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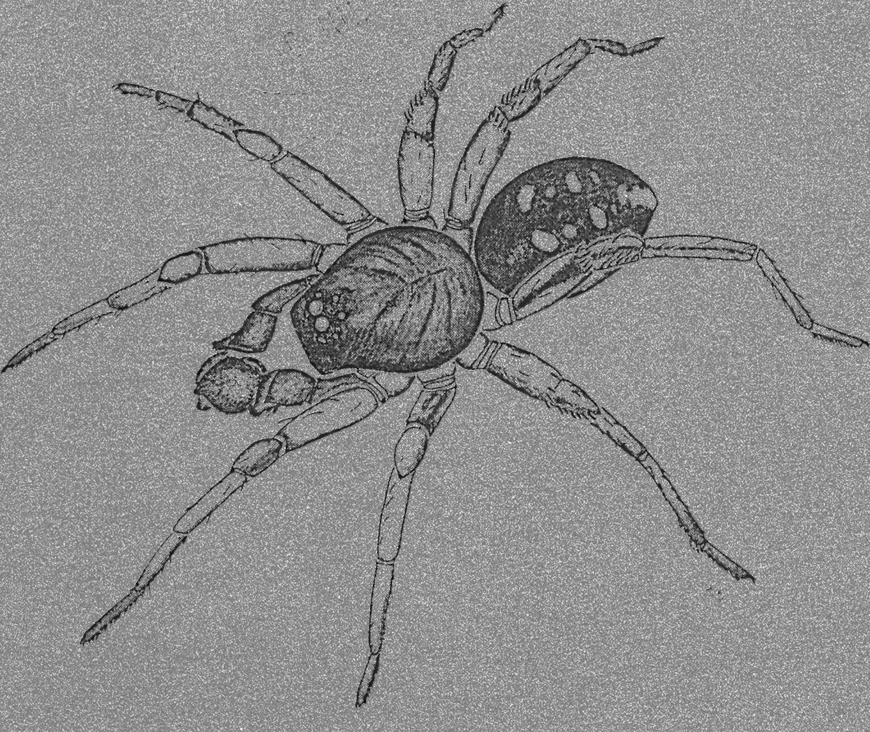

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Cover: This undescribed ant spider (Zodariidae), known only from the Expedition Range, is one of about 25 new *Habronestes* species from Queensland. In Australia, *Habronestes* is one of the most diverse genera of ant spiders with almost 130 species, of which only about one fifth are described. They are small to medium-sized spiders (2 – 12 mm in length) and most can be recognised by the bright yellow or orange spots on their backs and the distinctive palps of the males. Illustration by Barbara Baehr.

A FURTHER RECORD OF *APATURINA ERMINEA* (CRAMER) (LEPIDOPTERA: NYMPHALIDAE: APATURINAE) FROM AUSTRALIA

C.G. MILLER

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Abstract

A second confirmed male of *Apaturina erminea* (Cramer) is recorded from Iron Range, Queensland and an Australian specimen illustrated for the first time.

Introduction

Apaturina erminea (Cramer) occurs from Maluku in eastern Indonesia to the Solomon Islands, including Papua New Guinea and northeastern Australia, where it is known only from Iron Range, on Cape York Peninsula in northern Queensland (Braby 2000).

Wood (1981) recorded the capture of the first Australian specimen, a male, while Braby (2000) noted that very few specimens had been collected, including a female by J. Young. To date, no Australian specimen has been illustrated.

Discussion

A further male (Figs 1-2) was collected by the author on 21 May 2002, at the edge of the track leading to Mt Lamond at Iron Range. It was collected as it landed on a tree trunk at a height of 2.5 m from the ground, in full sunshine, at 1330 h. The behaviour of this specimen and the circumstances of its capture were very similar to those described by Wood (1981) and it is likely that the two specimens were collected within 100 m of each other.

Some nine subspecies are currently recognised but the subspecific status of the Australian population has not been determined. The present male differs from those of *A. e. papuana* Ribbe, illustrated by Braby (2000), in having less blue on the upperside of the hind wing and a darker underside (Figs 1-2). So far, only a brown female form is known from Australia, whereas two colour forms occur in Papua New Guinea (Braby 2000). Further material is needed to resolve the subspecific identity of the Iron Range population, which might be distinct.

The larval food plant has not been recorded but is believed to belong to the genus *Celtis* (Ulmaceae) (Braby 2000).

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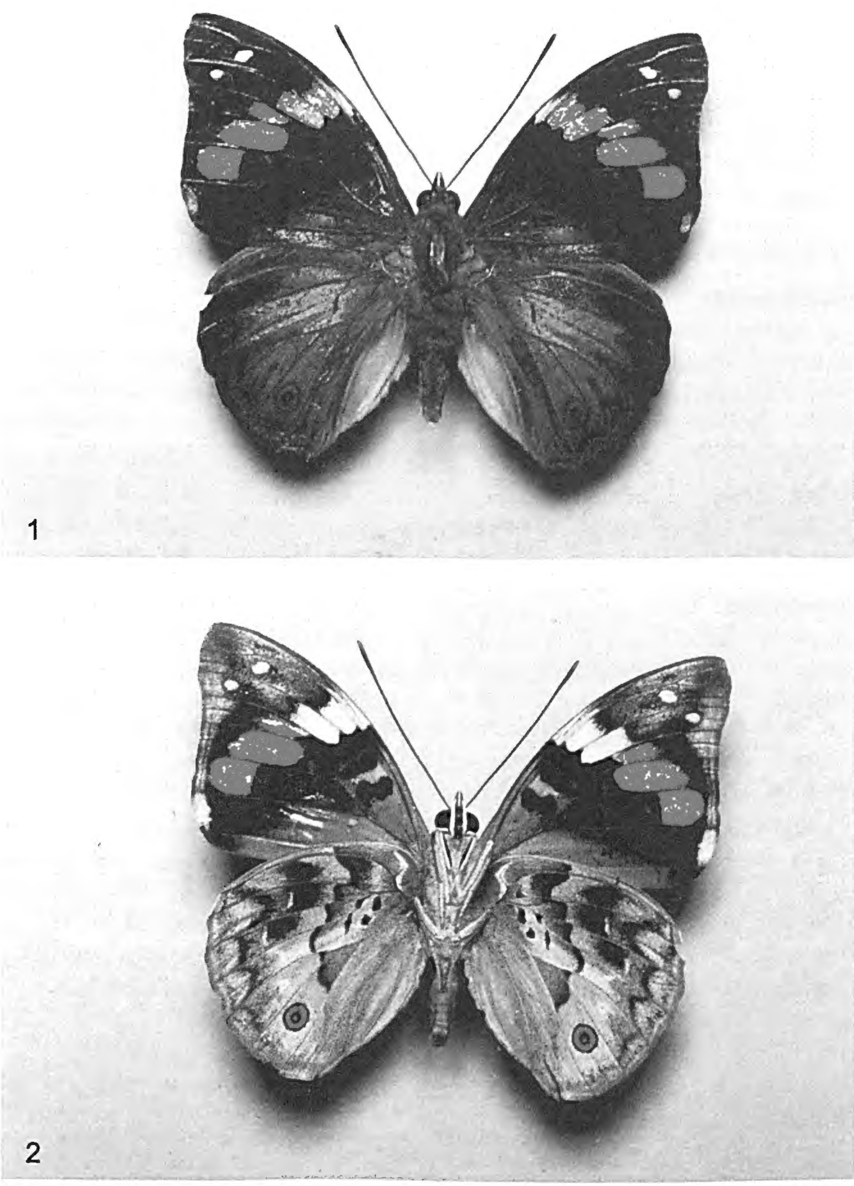
BRABY, M.F. 2000. *Butterflies of Australia: their identification, biology and distribution.* CSIRO Publishing, Collingwood; xx + 976 pp.

WOOD, G.A. 1981. First record of *Apaturina erminea* (Cramer) (Lepidoptera: Nymphalidae) from Australia. *Australian Entomological Magazine* **8**(1): 16.



Figs 1-2. *Apaturina erminea* (Cramer); male from Mt Lamond, Iron Range, northern Qld, 21 May 2002: (1) upperside; (2) underside.

EFFECTS OF LAND DISTURBANCE ON BUTTERFLIES (LEPIDOPTERA) ON A HILLTOP AT MURWILLUMBAH, NEW SOUTH WALES

GREG NEWLAND

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Abstract

A post-disturbance study of butterfly species richness and abundance was completed on the butterfly community of Hospital Hill, Murwillumbah, NSW. Butterfly species richness did not decline following disturbance; however a significant decrease in butterfly abundance was evident. Of the 21 hill-topping species known or thought to use Hospital Hill, a decrease in hill-topping activity was recorded for many species with one, *Polyura sempronius sempronius* (Fabricius) [Nymphalidae], virtually disappearing from the site.

Introduction

Hospital Hill is situated on the northern side of the business centre of Murwillumbah in northern New South Wales and is a dominant natural feature. The site is a habitat 'island' surrounded by extensive urban and agricultural development. Since 1930, it has been subjected to significant land disturbance, much of the original vegetation having been removed to accommodate water storage tanks, access roads and visitor facilities. Despite extensive clearing, many of the larger native trees have been retained and regrowth has occurred in many areas that were originally cleared. The Hospital Hill vegetation community comprises wet sclerophyll open forest and woodland species (Ecograph 2002). Dominant tree species include tallowwood (*Eucalyptus microcorys*), brush box (*Lophostemon confertus*) and pink bloodwood (*Eucalyptus intermedia*). In woodland areas, camphor laurel (*Cinnamomum camphora*) has become a major regrowth species. Eighteen butterfly larval food plant species have been recorded from the site.

Hill-topping in butterflies is a very complex behaviour which has been recognised as a mate location strategy, particularly in species which occur at low population densities (*e.g.* Shields 1967, Scott 1968, 1973, Atkins 1975, Common and Waterhouse 1981, Newland 1992, New 1997, Sands and New 2002). Factors that determine whether a site is used or not can be subtle (Baugham and Murphy 1988), and even small changes cause butterflies to abandon a site (Smithers 1996). The importance of hill-topping sites is out of proportion to their extent, so that a small area can be vital to the survival of species over a larger area, and the significance of competition among male butterflies has only recently been recognised as essential to preserving the genetic integrity of species which hilltop. Hilltops are also key sites for insects as prey for predatory birds and other invertebrates (Sands and New 2002).

A 13 megalitre reservoir was proposed by Tweed Shire Council for the summit of Hospital Hill, with site preparation work commencing in August 2003. The new reservoir, with a development footprint of 56 metres diameter,

replaces a 1.2 megalitre reservoir built in 1930. Available information suggested that the significance of the proposal on the value of Hospital Hill as a hill-topping butterfly site should be considered carefully (NSW National Parks and Wildlife Service 2003). The loss and/or degradation of sites used for hill-topping by butterflies is listed by the NSW Scientific Committee (2001) as a 'key threatening process' in Schedule 3 of the NSW Threatened Species Conservation Act 1995. A key threatening process is defined in this Act as 'a process that threatens, or could threaten, the survival or evolutionary development of species, populations or ecological communities'. The primary concern with respect to the impact of the proposal was that the development would contribute to the loss and/or degradation of Hospital Hill as a butterfly hill-topping site.

To determine effects of land disturbance associated with construction of the new reservoir on the use of Hospital Hill by butterflies, post-disturbance surveys were completed in 2003-2004 and compared with pre-disturbance surveys carried out by the author in 1991-1992. Butterfly species richness and abundance were the major criteria investigated, along with butterfly behaviour. Study of the effects of disturbance and the effectiveness of mitigation measures implemented has the potential to provide relevant, useful information that can be used to predict the impact of similar developments. Potential loss and/or degradation of summit sites used for hill-topping by butterflies is a matter other local government authorities are likely to have to consider when assessing proposed infrastructure developments at hilltop sites.

Materials and methods

Researchers, including Pollard (1977, 1982) and Thomas (1983), have developed techniques that estimate abundance and species richness in selected areas. These techniques involve walking along a predetermined route and recording all butterflies encountered within a set distance from the observer. A similar method was adopted for the studies carried out on Hospital Hill, together with a set of fixed criteria to maximise consistency in data collection. Studies suggest that estimates of butterfly abundance based on transect counts are more accurate than previously thought and provide an adequate basis for assessing a butterfly's status and needs (Pollard 1982).

When completing each transect survey, the transect route was travelled at a slow walking pace and all butterflies seen within an area extending 5 metres in front of and 2.5 metres either side of the observer were recorded. These distances were found to be the limits that would allow accurate recording. The first transect was commenced around 0930 h. General observations were then carried out until 1300 h, when a second transect was completed. Additional observations, where possible, were carried out until mid to late afternoon. One limitation was the difficulty in locating butterflies perched high above in tree canopies, particularly cryptic, fast-flying species. For this

reason, some hill-topping species, including those of the lycaenid genera *Hypochrysops* C. & R. Felder and *Acrodipsas* Sands, may still remain unrecorded from Hospital Hill.

Post-disturbance surveys of the summit butterfly fauna were carried out on one day every month for 12 months, from August 2003 to July 2004, using the same methodology employed in the 1991-1992 study (Newland 2005). This allowed comparison of data from both pre-disturbance and post-disturbance stages to determine effects of development on the hilltop butterfly fauna. As the 1991-1992-study period extended from November to February, comparisons with the post-disturbance study period were made for these months only.

Butterfly species richness

Species richness is arguably the most widely used indicator of the ecological diversity of a given area. It is often used as the biological measure of a habitat when decisions are to be made concerning conservation and management. Two components of species richness – number of species and species present, were compared for the two study periods. Butterfly species richness was recorded for each month; including species sighted during the day's observations but not recorded in transect surveys.

Number of species

Total number of species

The total number of species, including hill-topping species, was similar for both study periods, with summit disturbance having little effect on this component of species richness. During the November 1991-February 1992 study, 47 butterfly species were identified at Hospital Hill. From November 2003 to February 2004, 50 species were observed. The slightly higher number recorded during the post-disturbance study period may be due to several inconspicuous species being overlooked in the 1991-1992 study. Figure 1 compares the total number of species recorded for these months.

Number of hill-topping species

Compared with the 1991-1992 survey, the 2003-2004 study yielded two additional hill-topping species, with a total of 17 species recorded during the post-disturbance survey. The two additional species observed during 2003-2004, *Netrocoryne repanda* C. & R. Felder and *Hypocysta metirius* Butler, may have been present in 1991-1992 but were probably overlooked. The post-disturbance study recorded generally lower monthly numbers of hill-topping species (Figure 2).

Including species observed outside the study periods, 21 butterfly species (Table 1) are now known or thought to use the Hospital Hill site as a mate-locating rendezvous. This represents 29% of all butterfly species recorded from the site.

Species present

All species

Appendix 1 lists all species observed from the site, including those observed outside the study periods. Although the number of species recorded for both study periods remained relatively unchanged, the species recorded for each study period differed slightly, perhaps reflecting natural population fluctuations.

Table 1. Hill-topping butterfly species known or thought to use the Hospital Hill site, Murwillumbah. C = common; U = uncommon; L = local in distribution. * = species with males less abundant after disturbance of site; ^ = species observed in the vicinity of Hospital Hill and which probably also use the hilltop as a mate locating site.

Butterfly species	Status
HESPERIIDAE	
Netrocoryne repanda repanda C. & R. Felder	C, L
Toxidia peron (Latreille) *	C
PAPILIONIDAE	
Protographium leosthenes leosthenes (Doubleday) *	U
Graphium macleayanum macleayanum (Leach) *	C
Graphium sarpedon choredon (C. & R. Felder) *	C
Papilio anactus W.S. Macleay *	C
Cressida cressida cressida (Fabricius)	U
PIERIDAE	
Delias nigrina (Fabricius) *	C
Delias argenthona argenthona (Fabricius) *	C
NYMPHALIDAE	
Hypocysta metirius Butler	C
Polyura sempronius sempronius (Fabricius) *	U
Acraea andromacha andromacha (Fabricius) *	C
Hypolimnas bolina nerina (Fabricius) *	C
Junonia villida calybe (Godart)	C
Vanessa kershawi (McCoy)	C
Vanessa itea (Fabricius) ^	C, L
LYCAENIDAE	
Hypochrysops delicia delicia Hewitson ^	U, L
Ogyris olane (Hewitson)	U, L
Ogyris zozine (Hewitson)	U, L
Deudorix diovis (Hewitson)	C, L
Candalides absimilis (C. Felder) *	C

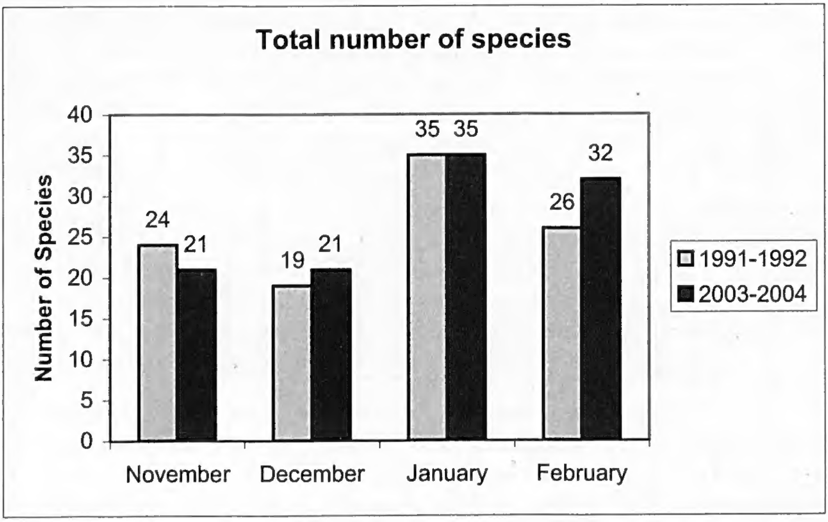

Fig. 1. Total number of species recorded from November to February at Hospital Hill, Murwillumbah, during 1991-1992 and 2003-2004.

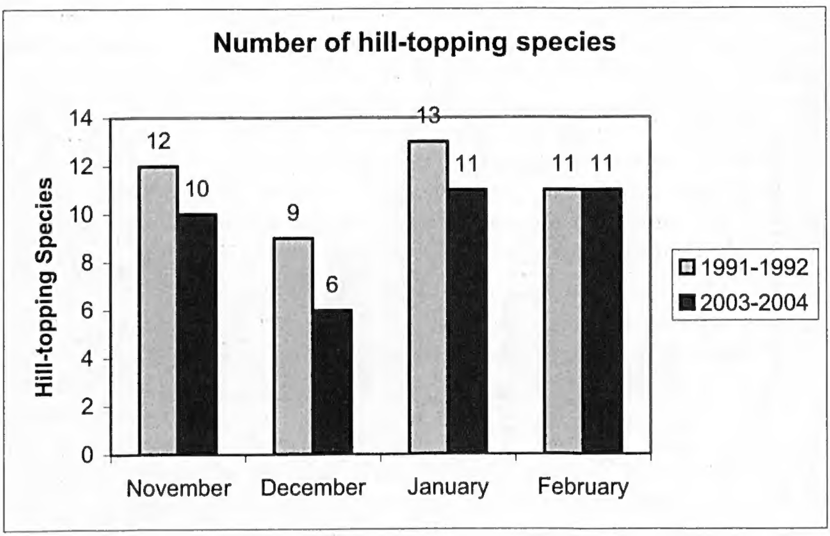

Fig. 2. Number of hill-topping species recorded from November to February at Hospital Hill, Murwillumbah, during 1991-1992 and 2003-2004.

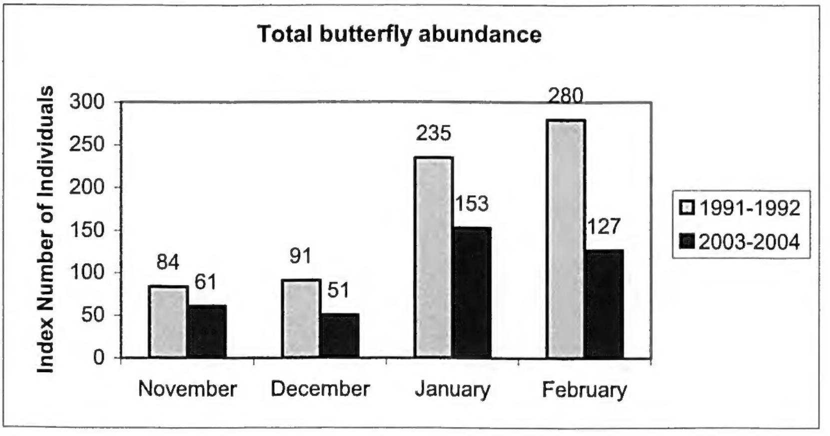

Fig. 3. Index of total butterfly abundance (individuals recorded during morning and afternoon transects) from November to February at Hospital Hill, Murwillumbah, during 1991-1992 and 2003-2004.

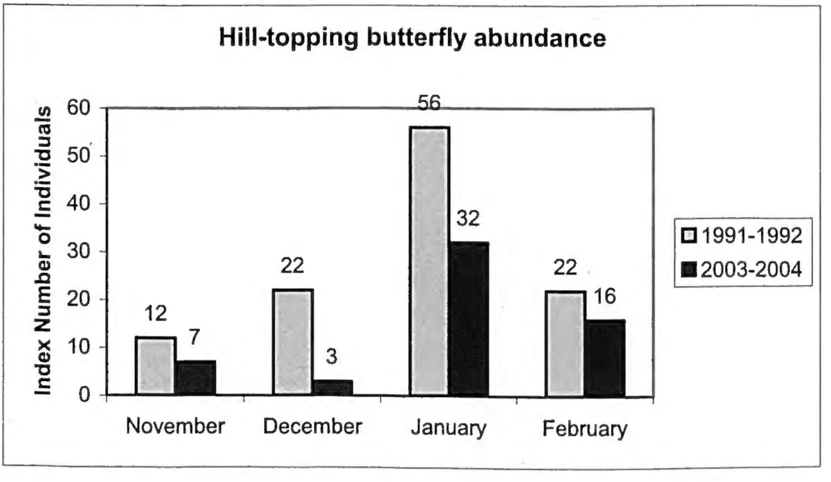

Fig. 4. Index of hill-topping butterfly abundance (individuals recorded during morning and afternoon transects) from November to February at Hospital Hill, Murwillumbah, during 1991-1992 and 2003-2004.

A small number of *Cupha prosope* (Fabricius) adults were observed in April-June 2004. This species was probably more widespread in the Tweed Valley prior to European settlement. The only other known occurrence of this butterfly is in Cudgen Nature reserve, north of Cabarita on the Tweed Coast. Hospital Hill is considered to constitute an important refuge for this species, as almost the entire surrounding coastal lowland rainforest habitat has been cleared for agriculture and residential development.

Seventy-four butterfly species have now been recorded from Hospital Hill (Appendix 1). This represents 35% of the 206 species known from the McPherson region (Dunn and Dunn 1991). When compared with the 96 species recorded from Mt Warning National Park (Newland 1999), it is evident that isolated remnant sites such as Hospital Hill represent important butterfly conservation refuges.

Hill-topping species

Several frequently observed, conspicuous hill-topping species were recorded for both study periods, including *Graphium macleayanum* (Leach), *G. sarpedon choredon* (C. & R. Felder), *Acraea andromacha* (Fabricius) and *Candalides absimilis* (C. Felder). Other, less conspicuous species, including *Netrocoryne repanda* and *Deudorix diovis* Hewitson, were recorded less frequently, being more difficult to detect. Table 1 lists all hill-topping species known or thought to use the site.

The most obvious result of hilltop disturbance on individual hill-topping species was the virtual disappearance of the nymphalid *Polyura sempronius* (Fabricius). Removal of perching sites and associated modification of the summit profile has had a detrimental effect on this species' use of Hospital Hill as a mate location site. Prior to the recent disturbance, males of *P. sempronius* were conspicuously present, patrolling the summit and perching on tree trunks, power poles and electrical or communications wires and equipment adjacent to the old 1.2 megalitre reservoir. Throughout the post-disturbance survey period, only one specimen was sighted, a male which flew over the summit briefly before departing.

Summit disturbance has also resulted in a decrease in abundance of many other hill-topping species. Although species which patrol close to the ground, such as *Papilio anactus* W.S. Macleay and *Acraea andromacha* were still present in the summit area, they were observed to be generally much less abundant or more sparsely distributed. Some high-flying species, including *Graphium macleayanum* and *Candalides absimilis*, suffered a similar decrease in abundance, although these species generally appear to have better adapted to loss of summit vegetation. Males were seen to modify their patrolling patterns following removal of mature summit trees, switching patrol areas to the tops of adjacent trees.

Butterfly abundance

Butterfly abundance was calculated as an index of the number of individuals recorded during both the morning and afternoons transect counts. Both total butterfly abundance and hill-topping butterfly abundance were significantly reduced following disturbance, despite the higher rainfall which occurred prior to and during the post-disturbance study (Figures 3, 4). This decrease in abundance reflects the loss of available habitat for both hill-topping and non-hilltopping butterfly species - a total of 0.2 hectares of hilltop habitat being lost as a result of vegetation clearing and site excavation for the new reservoir. This area was the highest point on Hospital Hill prior to the recent construction work and acted as a focus for much of the hill-topping activity for butterflies and other insects.

Discussion

Monitoring of the Hospital Hill butterfly fauna has enabled a detailed, quantitative assessment to be made of the effect of hilltop disturbance on the use of the site by butterflies. Although it is often difficult to determine if changes to the butterfly fauna at sites such as Hospital Hill are the result of human interference or are due to natural population fluctuation, results of this study suggest that decline in abundance of hill-topping males was a result of recent disturbance to the summit. A decrease in the ability of male butterflies to effectively compete for and mate with females has implications for the long term breeding success and maintenance of genetic fitness among local populations of affected species.

Results of this study also suggest that individual hill-topping species differ in their response to summit disturbance. Changes to the summit area adjacent to the old reservoir site have resulted in depletion or dispersal of hill-topping aggregations of many species which perch or patrol close to the ground. The virtual disappearance of *Polyura sempronius* confirms previous observations that even relatively small changes to the summit profile can cause some species to abandon a site. High-flying species, however, generally appear to have adapted better to disturbance, modifying their patrolling patterns in response to the altered summit vegetation profile. However, the reduction in tree canopy area would undoubtedly have reduced the total canopy area available for male butterflies to maintain individual territories.

Comparison of species richness alone to quantify effects of land disturbance on butterfly communities may lead to incorrect conclusions regarding the 'health' of butterfly hilltop communities. This study revealed a significant decline in populations of hill-topping species, although overall species richness was not affected. Assessment of effects of land disturbance on butterfly communities, therefore, should compare both species richness and abundance to more accurately quantify the effects of disturbance on sites thought to be important to the reproductive life cycles of butterflies. This is

of particular relevance if similar proposals are planned for other hilltops known or thought to support local butterfly populations which are geographically isolated or genetically distinct.

Promotion of native species regrowth and establishment of suitable nectar sources around the summit of Hospital Hill may assist in eventually mitigating negative effects of summit disturbance. Future surveys at this site should provide an indication of the effectiveness of compensatory plantings in restoring the abundance of depleted hill-topping butterfly species populations. When planning for and designing infrastructure such as observation towers, communications facilities and water reservoirs, careful consideration should be given to the effects of land disturbance to summit areas that are known or thought to serve as hill-topping sites. Siting of infrastructure a small distance below the summit (10-30 m) and minimising vegetation disturbance in order to preserve the summit profile, would greatly assist in ensuring the long-term survival and genetic fitness of hill-topping butterflies and other insects.

Acknowledgements

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Appendix 1

Butterfly species observed from 1977 to 2004 at Hospital Hill, Murwillumbah, NSW. Status (relative abundance): C = common; U = uncommon; L = local in distribution; S = sporadic in occurrence.

Butterfly species	Status
HESPERIIDAE	
Euschemon rafflesia rafflesia (W.S. Macleay)	U
Chaetocneme beata (Hewitson)	C, L
Netrocoryne repanda repanda C. & R. Felder	C, L
Hasora discolor mastusia Fruhstorfer	C
Hasora khoda haslia Swinhoe	C
Badamia exclamationis (Fabricius)	S
Trapezites symmomus symmomus Hübner	C
Toxidia rietmanni rietmanni (Semper)	C, L
Toxidia parvula (Plötz)	C, L
Toxidia peron (Latreille)	C
Ocybadistes flavovittatus flavovittatus (Latreille)	C

Butterfly species	Status
HESPERIIDAE (cont.)	
Ocybadistes walkeri sothis Waterhouse	C
Telicota colon argeus (Plötz)	C
Suniana sunias rectivitta (Mabille)	C
Telicota anisodesma Lower	C, L
Cephrenes augaides sperthias (C. Felder)	C
Cephrenes trichopepla (Lower)	C
PAPILIONIDAE	
Protographium leosthenes leosthenes (Doubleday)	U
Graphium macleayanum macleayanum (Leach)	C
Graphium sarpedon choredon (C. & R. Felder)	C
Graphium eurypylus lycaon (C. & R. Felder)	C
Papilio anactus W.S. Macleay	C
Papilio aegeus aegeus Donovan	C
Papilio fuscus capaneus Westwood	U
Cressida cressida cressida (Fabricius)	U
PIERIDAE	
Catopsilia pyranthe crokera (W.S. Macleay)	C
Catopsilia pomona (Fabricius)	C
Catopsilia gorgophone (Boisduval)	S
Eurema smilax smilax (Donovan)	C
Eurema hecabe hecabe (Linnaeus)	C
Elodina parthia (Hewitson)	S
Elodina angulipennis (P.H. Lucas)	C
Belenois java teutonia (Fabricius)	C
Cepora perimale scyllara (W.S. Macleay)	C
Appias paulina ega (Boisduval)	C
Delias nigrina (Fabricius)	C
Delias argenthona argenthona (Fabricius)	C
Pieris rapae rapae (Linnaeus)	C
NYMPHALIDAE	
Melanitis leda bankia (Fabricius)	C
Hypocysta metirius Butler	C
Heteronympha merope merope (Fabricius)	S
Polyura sempronius sempronius (Fabricius)	U
Acraea andromacha andromacha (Fabricius)	C
Cupha prosope prosope (Fabricius)	U, L
Phaedyma shepherdi shepherdi (Moore)	C

Butterfly species	Status
NYMPHALIDAE (cont.)	
Doleschallia bisaltide australis (C. & R. Felder)	U
Hypolimnas bolina nerina (Fabricius)	C
Junonia villida calybe (Godart)	C
Vanessa kershawi (McCoy)	C
Vanessa itea (Fabricius)	C, L
Tirumala hamata hamata (W.S. Macleay)	C
Danaus petilia (Stoll)	C
Danaus affinis affinis (Fabricius)	C
Danaus plexippus (Linnaeus)	C
Euploea tulliolus tulliolus (Fabricius)	U
Euploea core corinna (W.S. Macleay)	C
LYCAENIDAE	
Hypochrysops delicia delicia Hewitson	U, L
Ogyris olane (Hewitson)	U, L
Ogyris zozine (Hewitson)	U, L
Deudorix diovis (Hewitson)	C, L
Candalides absimilis (C. Felder)	C
Nacaduba berenice berenice (Herrich-Schäffer)	C
Nacaduba kurava parma (Waterhouse & Lyell)	C
Erysichton lineata lineata (Murray)	C
Pyschonotis caelius taygetus (C. & R. Felder)	C
Prosotas felderi (Murray)	C
Catopyrops florinda halys (Waterhouse)	C
Jamides phaseli (Mathew)	U
Catochrysops panormus platissa (Herrich-Schäffer)	U
Lampides boeticus (Linnaeus)	C
Leptotes plinius pseudocassius (Murray)	C
Zizina labradus labradus (Godart)	C
Everes lacturnus australis Couchman	U
Euchrysops cnejus cnidus Waterhouse & Lyell	U

A NEW SPECIES OF *CHARAXES* OCHSENHEIMER (LEPIDOPTERA: NYMPHALIDAE) FROM EAST TIMOR

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Abstract

Charaxes marki sp. n. is described and figured from East Timor and compared with *C. elwesi* Joicey & Talbot, *C. mars* Staudinger and *C. madensis* Rothschild, to which it shows some relationship.

Introduction

Charaxes Ochsenheimer is a predominantly Afrotropical genus of more than 140 known species (Smart 1975). Approximately 20 species are recorded from the Indo-Pacific region, extending as far east as the Bismarck Archipelago, Papua New Guinea (D'Abrera 1990, Tsukada 1991, Parsons 1998), but with a concentration of distribution in South East Asia. Only one species, *C. latona* Butler, is known to occur east of the Moluccas.

Tsukada (1991) depicted nearly all of the described *Charaxes*, including *C. musashi* Tsukada, a new species similar to *C. affinis* Butler, and a number of new subspecies. That work also covered several *Charaxes* subspecies described recently by Japanese authors (*e.g*. Hanafusa 1985, Morinaka 1990, Nishiyama and Ohtani 1981) from the Lesser Sunda Islands. However, both D'Abrera (1990) and Tsukada (1991) recorded only *C. orilus* Butler from East Timor.

Recent fieldwork by one of us (DL, in conjunction with Mark Lane) in East Timor has yielded a highly distinctive, previously undescribed species of *Charaxes*, showing affinities with *C. elwesi* Joicey & Talbot, *C. mars* Staudinger and *C. madensis* Rothschild. It is described below.

Charaxes marki sp. n.
(Figs 1-3)

Type. *Holotype* ♂, EAST TIMOR: 5 km NW Bobonaro, 1000 m, 9°00'35"S, 125°17'E, 20.i.2004, D.A. & M.D. Lane (in Australian National Insect Collection (ANIC), Canberra).

Description. Male (Figs. 1-2). Forewing length 41 mm (centre of thorax to apex). Head, thorax and abdomen brown; antennae half length of costa. Forewing with costa strongly bowed from 1/2 to 3/4 towards apex, fairly straight otherwise; apex sharply acute; termen gradually then strongly concave to CuA_2, then angled basally; tornus sharply rounded; dorsum straight. Hindwing termen rounded from apex to CuA_1, then strongly indented to 1A; tornus sharply rounded, dorsum slightly bowed. A tooth-like tail projection 5 mm long extends along CuA_1.

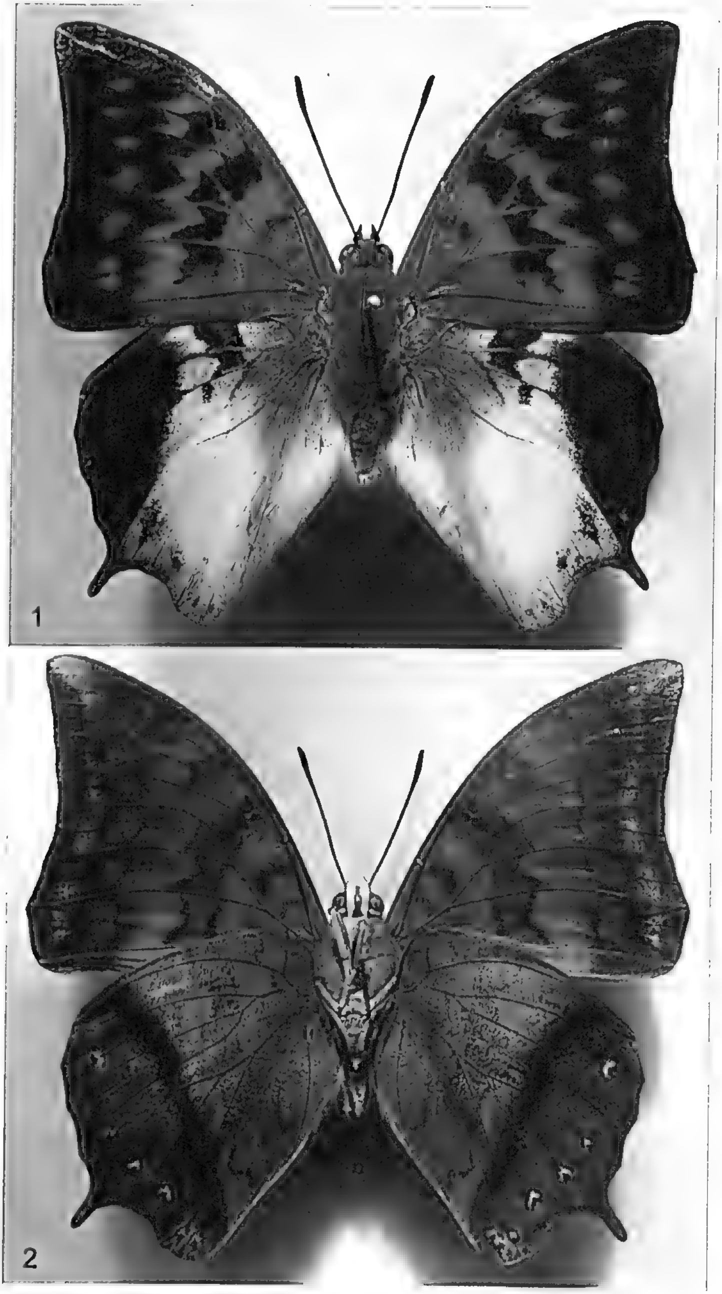
Forewing upperside broadly black, orange basally for 1/3 but with a black central band in discal cell; an orange median band, strongly indented between veins, extends from costa to dorsum; a much shorter postmedian band, similarly indented between veins, extends from costa to M_2. A subapical and subterminal band, which is a series of orange spots centrally located between veins, extends parallel to termen, but not reaching dorsum. Hindwing upperside broadly black, basally brown. A broad white patch extends from dorsum across lower half of hind wing to CuA_1, then centrally across outer cell and postmedian area to M_2, therein extending to costa but in that area overlaid with orange, giving a rusty brown appearance. A black median band, indented between veins, extends from costa to just above cell. A row of black subtornal spots located between veins and overlaying white patch extends from tornus to CuA_1. Forewing underside broadly grey-brown, with a mirror image of upperside orange bands much paler, edged black/dark brown; a grey patch at apex, extending into a grey terminal band that runs parallel to termen but not reaching dorsum; termen area brown. Hindwing underside broadly grey/brown, with grey fleck overlay; a series of light orange submedian and median patches, faintly edged black; terminal area brown, with a row of black spots, edged white and indented basally, located between veins, extends from apex to tornus in an arc roughly parallel to termen; a distinctive brown band extends from apex, bowed slightly basally, to just above tornus.

Male genitalia (Fig. 3, Genitalia slide ANIC 18571). Tegumen elongate, bulbous posteriorly, broad and keel-shaped laterally; sociuncus with prominent crown posteriorly, bent backwards, uncus sharp laterally and broad, saddle-shaped dorsally, with numerous long fine setae; vinculum uniformly very narrow; gnathos brachia acute, nearly parallel to uncus in lateral view; valvae broad and tapered apically in lateral view, dorsally with single large sclerotised hook apically, outer edge of valvae irregular, covered with long fine setae; juxta long and narrow, tapered apically, strongly bowed downwards, weakly bifurcated posteriorly, with pair of proximal fine processes, aedeagus elongate and irregular, bulbous posteriorly with very sharply tapering apex, adorned dorsally along prominent ridge with very short, evenly spaced black spines along apical third of aedeagus.

Female. Unknown.

Etymology. Named after Mark Lane, who spent seven months in East Timor in 2002, under a United Nations military deployment. During this period Mark collected many interesting specimens of moths and butterflies, often under extremely difficult and arduous conditions.

Comments. *Charaxes marki* is a distinctive species readily distinguishable by its wing shape, pattern, colouration and male genitalic characters. In particular, the strongly contrasting fore and hind wing colouration is very striking.



Figs 1-2. *Charaxes marki* sp. n., holotype male. (1) upperside; (2) underside.

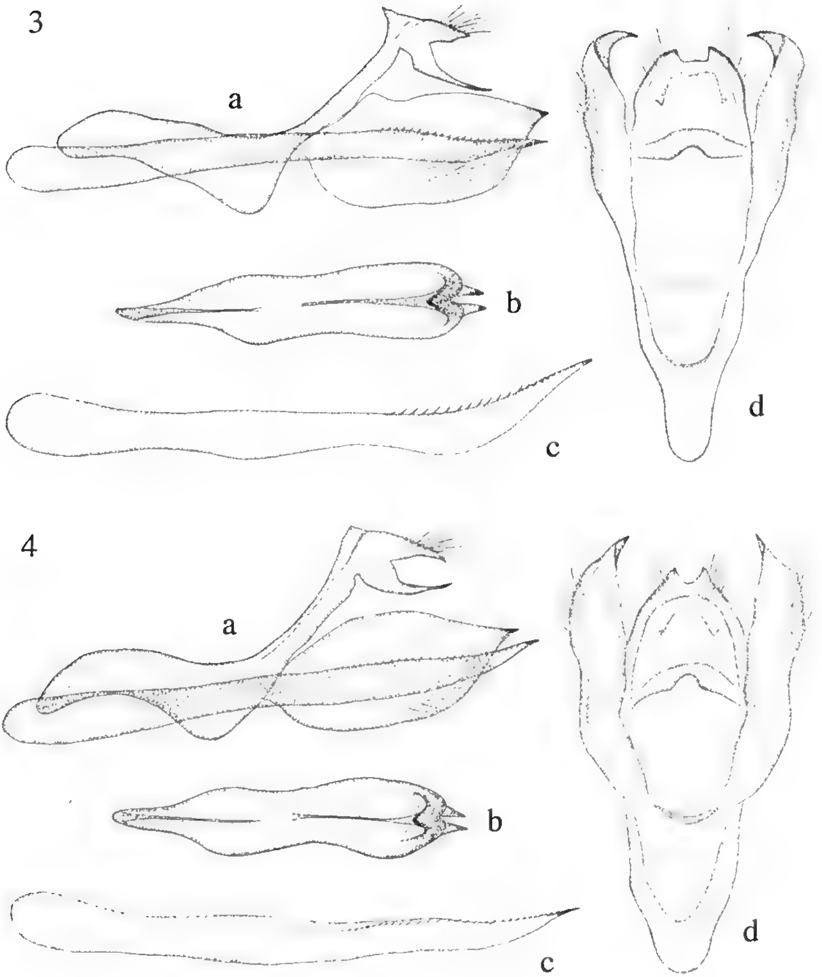


Fig. 3-4. *Charaxes* spp., male genitalia. (3) *C. marki* sp. n., genitalia slide ANIC 18571: (a) genitalia with right valva removed, lateral view, 10X; (b) juxta, ventral view, 20X; (c) aedeagus, lateral view, 10X; (d) genitalia, dorsal view, 10X. (4) *C. elwesi:* (a) genitalia with right valva removed, lateral view, 10X; (b) juxta, ventral view, 20X; (c) aedeagus, lateral view, 10X; (d) genitalia, dorsal view, 10X.

The holotype has an unusually shaped hind wing unlike any other known Indo-Pacific *Charaxes* species. It is distinct in that the sub-tornal part of the termen between the single, very prominent tail and the tornus is strongly indented and the inner margin is very pale cream, quite unlike all other described *Charaxes* species in the region.

C. mars (from Sulawesi), *C. madensis* (from Buru) and *C. elwesi* (from the Lesser Sunda Islands) all show some relationship to the new species. In all of these species, except *C. madensis*, the costal third of the hindwing upperside is darkened and the submarginal dark spots are represented as elongated flecks. The male forewing upperside of *C. marki* is reminiscent of *C. madensis*, having a dark brown ground colour with several bands of dull orange-brown. Beneath, the colouration and pattern reflects *C. elwesi* but it is much sootier than that species. The postmedian band configuration of *C. marki* is similar to that of *C. elwesi* but this band is much narrower, and bowed towards the termen at both the tornus of the forewing and the apex of the hind wing in *C. marki*, while it is comparatively straight in *C. elwesi*.

Genitalic characters are generally poorly diagnostic among the Indo-Pacific Charaxinae (C. Müller, pers. obs.; Smiles (1982) for *Polyura* Billberg). The U-shaped sociuncus (in dorsal view), short but sharp gnathos brachia, sclerotised valvae and simple, strongly tapered aedeagus are all characteristic of Indo-Pacific *Charaxes*. However, *C. marki* shows a number of distinctive features when compared with *C. mars*, *C. madensis* and *C. elwesi* (Fig. 4), features of the latter suggesting the closer relationship. The overall squat appearance of the genitalia in dorsal view may be attributed to the broad valvae with a thickened sclerotised hook apically as well as the rounded sociuncus which lacks the pronounced uncus spines found in the other taxa. The vinculum is very narrow and of uniform thickness in *C. marki* and the saccus is simple and less bowed than in the other taxa. Additionally, the juxta, viewed ventrally, is very long and tapered apically and the aedeagus is irregular along its edges. Also, the short, evenly spaced spines along the dorsal ridge of the aedeagus are thicker than in the other taxa examined.

Observations

The area in which *C. marki* was observed is a series of limestone ridges and outcrops, clothed in dense vine scrub. The holotype was collected on the summit of one of these limestone ridges and appeared to portray typical hill-topping behaviour. *Polyura galaxia galaxia* Butler was a regular visitor to these same ridge tops. *Charaxes orilus* was collected on lower sections of the ridges and did not appear to exhibit hill-topping behaviour.

Acknowledgements

Mr Mark Lane is thanked for his assistance in the field during 2004, and for his many contributions during 2002. Mr E.D. Edwards (ANIC) is thanked for his generous advice, and Dr M.S. Moulds for helping with literature sources.

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A NEW SPECIES OF *POLYRHACHIS (AULACOMYRMA)* EMERY (HYMENOPTERA: FORMICIDAE: FORMICINAE) FROM PAPUA NEW GUINEA

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Abstract

Polyrhachis (Aulacomyrma) enigma sp. n. is described and illustrated from Mt Missim, Papua New Guinea.

Introduction

Ants of the subgenus *Aulacomyrma* Emery of *Polyrhachis* Fr. Smith are largely restricted to New Guinea, with species occurring from the eastern Indonesian islands of Aru and Misool, across mainland New Guinea, to the Bismarck Archipelago, including New Britain and New Ireland. A recent revision of the subgenus (Kohout, in press) recognised 36 species. Subsequently, another species was discovered, represented by a single worker and three dealate queens from Papua New Guinea. The worker superficially resembles a member of the subgenus *Cyrtomyrma* Forel (where I had originally placed it), but characters of the queens indicate that it is best placed within *Aulacomyrma*. This remarkable new species is described below.

Methods

Photographs were taken using a ProgRes 3012 scanning digital camera (Jenoptik) attached to a Leica MZ16 stereomicroscope. Images were then processed using Auto-Montage (Syncroscopy, Division of Synoptics Ltd, USA) and Photoshop (Adobe Inc., USA) software. Standard Measurements and Indices: TL = Total length (the necessarily composite measurement of the outstretched length of the entire ant measured in profile); HL = Head length (the maximum measurable length of the head in perfect full face view, measured from the anteriormost point of the clypeal border or teeth, to the posteriormost point of the occipital margin); HW = Head width (width of the head in perfect full face view, measured immediately in front of the eyes); CI = Cephalic index (HW x 100/HL); SL = Scape length (excluding the condyle); SI = Scape index (SL x 100/HW); PW = Pronotal width (greatest width of the pronotal dorsum); MTL = Metathoracic tibial length (maximum measurable length of the tibia of the hind leg). Measurements were taken using a Zeiss SR stereomicroscope with an eyepiece graticule calibrated against a stage micrometer. All measurements are expressed in millimetres.

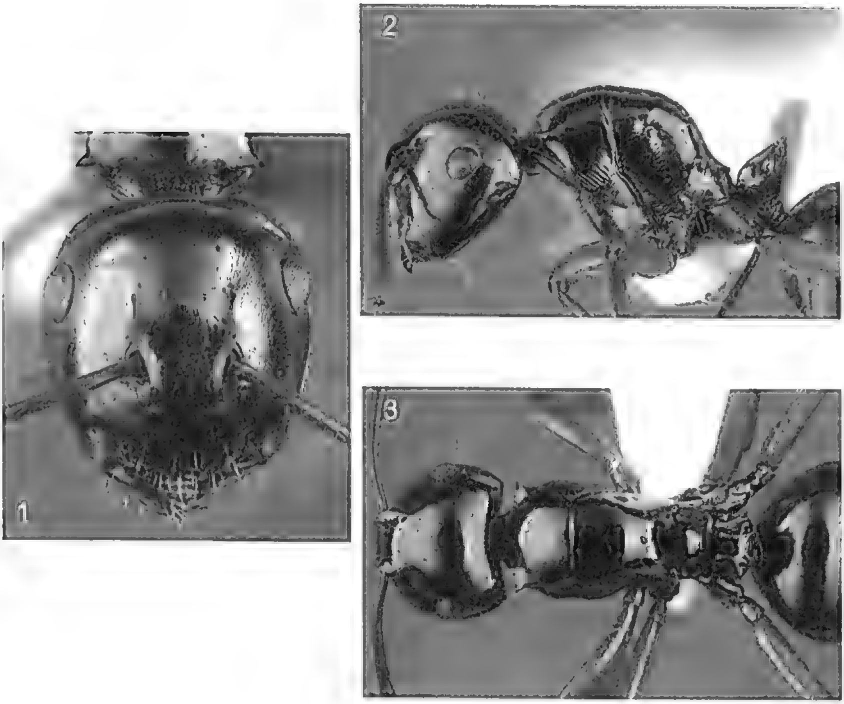
Abbreviations of institutions (with names of curators) are: ANIC = Australian National Insect Collection,, Canberra (S.O. Shattuck, R.W. Taylor); BMNH = The Natural History Museum, London (B. Bolton); MCZC = Museum of Comparative Zoology, Harvard University, Cambridge (S.P. Cover); QMBA = Queensland Museum, Brisbane (C. J. Burwell, G.B. Monteith).

***Polyrhachis (Aulacomyrma) enigma* sp. n.**

(Figs 1 - 3)

Types. Holotype worker, PAPUA NEW GUINEA: Morobe Prov., Mt Missim (Mt. Misim on label), 07°20'S, 146°43'E, (no date of collection), Stevens. *Paratypes*: 3 dealate queens, Eastern Highlands, Mingende, 05°58'S, 144°53'E, 5000 ft, 14.i.1968, B.B. Lowery. Holotype in MCZC; 1 paratype each in ANIC, BMNH and QMBA.

Description. Worker. Dimensions: TL c. 6.05; HL 1.56; HW 1.50; CI 96; SL 1.72; SI 115; PW 1.15; MTL 1.93. Black; mandibles reddish-brown with teeth, inner and outer borders and base narrowly lined dark brown. Antennae dark brown with apex of last funicular segment distinctly lighter, yellowish-brown. Mandibles with 5 teeth, reducing in length towards base. Anterior clypeal margin widely and shallowly emarginate medially. Clypeus in profile very weakly sinuate; posteriorly with rather vague, short, blunt, medial carina; basal margin flat, laterally indicated by thin line. Frontal triangle indistinct. Frontal carinae sinuate, rather short, with moderately raised margins anteriorly, rather flat posteriorly; central area relatively wide with weakly raised medial carina. Sides of head in front of eyes weakly concave, converging towards mandibular bases; widely rounded behind eyes into weakly convex occipital margin. Eyes rather small, moderately convex, situated well forward from occipital corners; in full face view marginally exceeding lateral cephalic outline. Ocelli absent. Pronotal humeri with dorsally flattened triangular teeth, their lateral margins continued for a short distance forming incomplete lateral pronotal margins. Mesosoma in profile weakly convex; promesonotal suture distinct; mesonotum with weakly indicated lateral margins, almost flat in profile; metanotal groove lacking; propodeum laterally emarginate, with dorsum smoothly rounding into oblique declivity. Petiole scale-like, with anterior face almost flat, posterior face weakly convex; dorsal margin armed with pair of acute dorsal teeth and pair of more slender, short, lateral spines; margins between dorsal teeth and lateral spines somewhat jagged, with additional pair of blunt denticles. Anterior face of first gastral segment lower than height of petiole, with anterodorsal margin widely rounding onto dorsum of segment. Mandibles at masticatory borders longitudinally rugose, rather polished towards bases. Legs light orange-red with distal ends of femora narrowly and proximal ends of tibiae more widely black; tarsi mostly dark brown with apical segments distinctly lighter, yellowish-brown. Whole body surfaces extremely finely shagreened, with dorsum of head and mesosoma highly polished. Sides of pronotum with numerous shallow striae directed obliquely towards very finely wrinkled lateral lobes; mesonotum and propodeum with numerous, shallow, oblique striae. Abundant shallow punctures scattered over most body surfaces. Mandibles with a few short, curved and semierect hairs near masticatory borders and along outer margins; towards bases with numerous, very short, appressed hairs arising from pits. Clypeus with several short setae lining anterior margin. All body surfaces with numerous, scattered, rather



Figs 1-3. *Polyrhachis (Aulacomyrma) enigma* sp. n., worker (1) frontal view of head; (2) lateral view of head, mesosoma and petiole; (3) dorsal view of head, mesosoma and petiole.

short, semierect or appressed hairs arising from shallow punctures and pits. Posterior margins of gastral segments lined with medium length, erect hairs, distinctly longer hairs concentrated around gastral apex. Leading edge of antennal scapes with several short, erect hairs. Legs with only a few, medium length hairs arising from ventral surfaces of femora and dorsal surfaces of middle and hind tibiae.

Queen. Dimensions: TL c. 7.06-7.36; HL 1.75-1.81; HW 1.59-1.68; CI 91-93; SL 1.68-1.84; SI 104-114; PW 1.25-1.31; MTL 1.93-2.03 (3 measured). Black, with colour scheme virtually identical to that in worker. Very similar to worker with usual characters identifying full sexuality, including three ocelli and complete thoracic structure. Clypeus in profile straight, with blunt, longitudinal carina medially; basal clypeal margin flat. Eyes more convex than in worker, clearly breaking lateral cephalic outline. Pronotal humeri with blunt triangular teeth; mesoscutum slightly wider than long with lateral margins strongly converging anteriorly, forming narrowly rounded anterior margin; median line very short, poorly indicated; parapsides distinct, rather

flat; mesoscutum in profile relatively low, widely rounding onto flat dorsum. Mesoscutellum flat, not elevated above dorsal plane of mesosoma; metanotal groove strongly impressed. Propodeum wide, strongly transverse, convex in profile, laterally terminating into blunt angles; dorsum descending into steeply oblique declivity in medially uninterrupted line. Petiole with dorsal margin sharp, entire, laterally weakly rounding into short, acute, posterolaterally curved spines. Subpetiolar process triangular. Anterior face of first gastral segment low, smoothly rounding onto dorsum. Mandibles rather distinctly, longitudinally rugose. Head, including clypeus with very faint, longitudinal striae, more distinct between eyes and frontal carinae. Mesosoma laterally with striae more distinct than those in worker; mesoscutum anteriorly with longitudinal, medially converging, rather weakly indicated striae. Propodeal dorsum distinctly, longitudinally striate with declivity and petiole very finely, mostly transversely, reticulate. All dorsal surfaces of head, mesosoma and gaster very finely shagreened, highly polished, but not as shiny as in worker. Male and immature stages unknown.

Remarks. The holotype is the only available worker of this species and nothing is known about its nesting habits. In general appearance, including the scale-like petiole, it closely resembles some members of the subgenus *Cyrtomyrma*. However, the shape of the head that almost completely lacks a lateral carina, and the partially developed lateral margins of the pronotum and mesonotum, exclude it from *Cyrtomyrma*. In particular, the queens closely resemble some members of the recently established *P. porcata*-group of *Aulacomyrma* (Kohout, in press) and their distinguishing characters, including the poorly defined lateral margins of the mesosoma and the arcuate dorsal margin of the petiole with short lateral teeth, support the placement of *P. enigma* within this latter subgenus. In spite of the distance (about 260 km) separating their collection localities, the holotype worker and paratype queens share most of the specific morphological characters and I am confident that they represent a single biological species.

Acknowledgements

I am grateful to Stefan Cover (MCZC), Steve Shattuck and Bob Taylor (both ANIC) for unlimited access to the *Polyrhachis* collections in their care. This work was supported by two Harvard University Ernst Mayr Grant Awards allowing a visit to the MCZC. I am also indebted to Natalie Barnett (ANIC) for help in obtaining the digital images and Chris Burwell (QMBA) for commenting on a draft of the manuscript.

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CLINAL VARIATION IN FEMALE *HYPOLYCAENA PHORBAS PHORBAS* (FABRICIUS) (LEPIDOPTERA: LYCAENIDAE) AND REVISION OF THE STATUS OF *H. P. INGURA* TINDALE

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Abstract

Hypolycaena phorbas (Fabricius) from Queensland and the Northern Territory is reviewed. Females were found to form a cline in Queensland, with predominantly pale forms occurring in the south, progressing to mostly dark forms at the northern extremity of its range. This trend was found to be unrelated to season. Dark specimens from the northern Torres Strait islands were found not to differ from specimens from the Northern Territory and northern Western Australia, and further evidence is provided to place *H. p. ingura* Tindale as a junior synonym (syn. n.) of *H. p. phorbas*. There is no evidence to indicate that variation in males is also clinal, with male variations found to occur randomly throughout the range of *H. phorbas*. The current known distribution of the species in Torres Strait is summarised.

Introduction

Within Australia, *Hypolycaena phorbas* (Fabricius) occurs in a variety of coastal and subcoastal habitats, extending from the Mitchell Plateau in Western Australia, through the northern part of the Northern Territory and into Queensland, including the northern Torres Strait islands (Braby 2000, Lambkin *et al.* 2005), the west coast of Cape York Peninsula (Hancock and Monteith 2004) and the east coast from Cape York to Tannum Sands, just south of Gladstone (Braby 2000). Two subspecies are recognized from Australia; *H. p. phorbas* (Fabricius) is known from tropical Queensland, while *H. p. ingura* Tindale is recorded from northern Western Australia and northern areas of the Northern Territory (Braby 2000). The two subspecies are distinguished primarily on the basis of the size of the central cream-coloured patch on the upperside of the forewing in females. In *H. p. ingura* this white patch is normally much less prominent and covered with blue-grey scales, or sometimes absent (Tindale 1923, Braby 2000).

Prior to the mid 1970s, almost all known specimens of *H. p. phorbas* were from mainland Queensland, south of Cape York Peninsula, and its coastal islands (Braby 2000), with a relatively small number known north of Cooktown (Waterhouse and Lyell 1914). Since then, more systematic collecting of butterflies on Cape York Peninsula and in Torres Strait has been undertaken, with many more specimens of *H. p. phorbas* now known from Cape York Peninsula and many of the Torres Strait island groups (Braby 2000). In general, specimens of *H. phorbas* from the more northern Torres Strait islands have been difficult to assign taxonomically (Braby 2000), a problem compounded by the existence of a similar species, *H. litoralis* Lambkin, Meyer, Brown & Weir, recently identified from the same islands (Lambkin *et al.* 2005). The upperside facies of male *H. p. phorbas* are also variable, with the upperside colouration of both wings varying from greenish-

blue to purple (Waterhouse and Lyell 1914), and with many specimens possessing a variable area of white scales on the forewing in the area below the sex brand, above vein 1A+2A. Braby (2000) reported that the upperside colour of males in the southern end of the species' range tended to be darker and duller blue. Parsons (1998) reported that both sexes of *H. phorbas silo* Fruhstorfer from Papua New Guinea were also variable, with some males also possessing white scales above vein 1A+2A.

An examination of specimens of both sexes of *H. p. phorbas* from Queensland has indicated that female specimens north of Cooktown are, like *H. p. ingura*, highly variable in the extent of the forewing cream patch, with many specimens indistinguishable from *H. p. ingura*. Males of *H. p. phorbas* are highly variable, even from the same geographical area, and therefore it is difficult to assign particular colour forms to geographical areas. However, in Queensland, the female variation appears to be clinal. In this paper, the variation in the external upperside facies of female *H. p. phorbas*, in particular the size and character of the central cream/bluish-grey patch of the forewing, is documented, illustrated and analysed to determine if this variation is clinal. Variation in males from Queensland and Northern Territory/Western Australia is also reviewed in order to determine if they form part of this cline. In light of the findings of this study, the status of *H. p. ingura* is revised. Abbreviations used for specimen depositories and collectors are listed in Appendix 1.

Methods and materials

A microscopic examination of the forewing patches of female *H. phorbas* indicated that the patches consist of, when present, densely packed cream-coloured scales, overlaid with a variable number of much sparser greyish-blue scales. In this study, 318 females (Appendix 1) of *H. phorbas* from mainland Queensland, Torres Strait, Northern Territory and Western Australia were examined and, in general, almost all specimens could be placed into one of three morphological groups. These groups were categorised relative to the size and scale structure of the central forewing patch, and the prominence of subterminal rings and extent of white and bluish-grey scaling on the hindwing upperside. The specimens were further grouped relative to their collection sites and placed into four nominated geographical zones. The boundaries of these zones were designated to be locations where morphological characters appeared to change. Specimens within each morphological group from each geographical zone across the species' range were counted and compared in order to determine if the variation was clinal. As well, the month of capture for each specimen from each morphological group in each geographical zone was tabulated in order to detect any seasonal effect on morphology.

The morphological groups chosen (upperside of females) with distinguishing facies were:

Morph group 1: Forewing with extensive area of cream scales (greater than half the size of the patch), partly overlaid with a large area of dense bluish-grey scales. Hind wing with prominent white and bluish-grey scales and with prominent subterminal rings (Figs 1, 2).

Morph group 2: Forewing with restricted area of cream scales (less than half the size of the patch), overlaid totally with a much larger area of dense bluish-grey scales. Hind wing with reduced bluish-grey scales and with prominent subterminal rings (Figs 3, 4).

Morph group 3: Forewing without cream or bluish-grey scales or with only a dusting of scales. Hind wing without coloured scales and with white subterminal rings markedly reduced or blurred (Figs 5, 6).

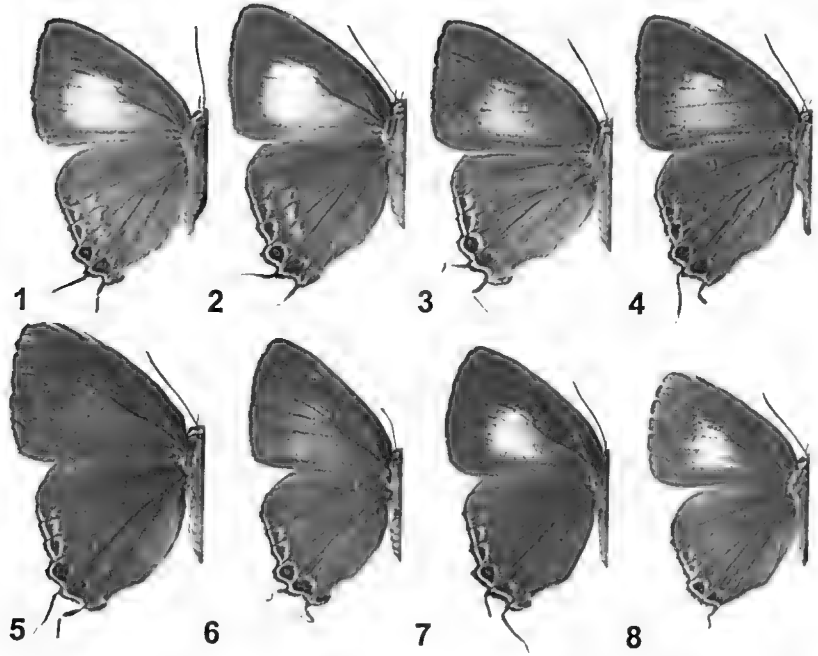
Another morphological group was identified (Figs 7, 8), but it was not considered for the study as it was consistently rare across all geographical zones (between 3 and 6 specimens per zone), and had no bearing on the study. Its external facies were: forewing with large area of cream scales without bluish-grey scales; hind wing without coloured scales and with blurred subterminal rings.

The geographical zones designated across the species' range were: Zone A - coastal Queensland from Gladstone north to and including Cooktown; Zone B - coastal Queensland from north of Cooktown to and including the Thursday Island group of islands in Torres Strait, plus western Cape York Peninsula; Zone C – central, eastern and northern Torres Strait islands; Zone D - Northern Territory and northern Western Australia.

In addition, 123 males of *H. phorbas* (Appendix 2) from Queensland and the Northern Territory/Western Australia were firstly grouped into the four geographical zones. The specimens were then examined to determine if any morphological characters, such as the extent or type of upperside colouration, or the presence of white scales on the forewing in the area above vein 1A+2A, could be linked to the geographical zones.

Results

The number of females in each morphological category from each geographical zone, and the percentage of each of the total, were grouped and tabulated, including months of capture for all specimens (Table 1). The majority of specimens (73.5%) from the most southern region (Zone A) had extensive areas of cream scales (morph group 1), with this feature progressively diminishing in specimens from Zone B (44.6% of specimens), to a very low frequency in the most northern regions (Zones C and D: 12.1% and 5.6% respectively). Inversely, the frequency of the two darker morph groups (2 and 3) progressively increased from south to north, to an extent that the majority of specimens north of Cooktown (Zones B, C and D) had generally dark upperside facies.



Figs 1-8. *Hypolycaena phorbas*, upperside of females. All figures to scale [forewing lengths in parentheses]: (1) Iron Range, Qld, 4-12.vii.1995, JWCD (ANIC) [18 mm]; (2) Thursday I., Qld, 23-30.vii.1983, TAL (TLIKC) [19 mm]; (3) Dauan I., Qld, 14.v.2001, AIK (TLIKC) [20 mm]; (4) Thursday I., 12.xii.1993, TAL (TLIKC) [19 mm]; (5) Dauan I., 28.i.2004, AIK (TLIKC) [20 mm]; (6) Darwin, NT, 1-22.iii.2003, RPW (TLIKC) [17 mm]; (7) Dauan I., 3.v.2001, AIK (TLIKC) [18 mm]; (8) Yorke I., Qld, 15.vi.1973, JWCD (ANIC) [17 mm].

Figs 9-24. *Hypolycaena phorbas*, upperside of males. All figures to scale [forewing lengths in parentheses]: (9) Dauan I., Qld, 21.iii.2004, TAL (TLIKC) [18 mm]; (10) Dauan I., 19.ii.2004, TAL (TLIKC) [17 mm]; (11) Dauan I., 21.ii.2004, TAL (TLIKC) [17 mm]; (12) Dauan I., 29.i.2004, AIK (TLIKC) [18 mm]; (13) Cape Wessell, NT, 26.vi.1973, JWCD (ANIC) [16.5 mm]; (14) East Point, Darwin, NT, 28.iv.-3.v.1993, AIK (TLIKC) [16 mm]; (15) Darwin, 1-22.iii.2003, RPW (TLIKC) [15 mm]; (16) Kalumburu, WA, 13.v.1991, JWCD (ANIC) [15 mm]; (17) Thursday I., Qld, 12-15.iv.1992, TAL (TLIKC) [15 mm]; (18) Cape York, Qld, 21.x.1979, JWCD (ANIC) [16 mm]; (19) Thursday I., 22.vi.1973, JWCD (ANIC) [17 mm]; (20) Thursday I., 23-31.vii.1983, TAL (TLIKC) [16 mm]; (21) Townsville, Qld, 20.xi.1984, PSV (TLIKC) [17 mm]; (22) Great Keppel I., Qld, 25.xii.2002, JSB (JSBC) [17 mm]; (23) Yeppoon, Qld, 3-4.i.1979, TAL (TLIKC) [19 mm]; (24) Allingham, Qld, 10.iii.1982, PW (DPIFC) [18 mm].

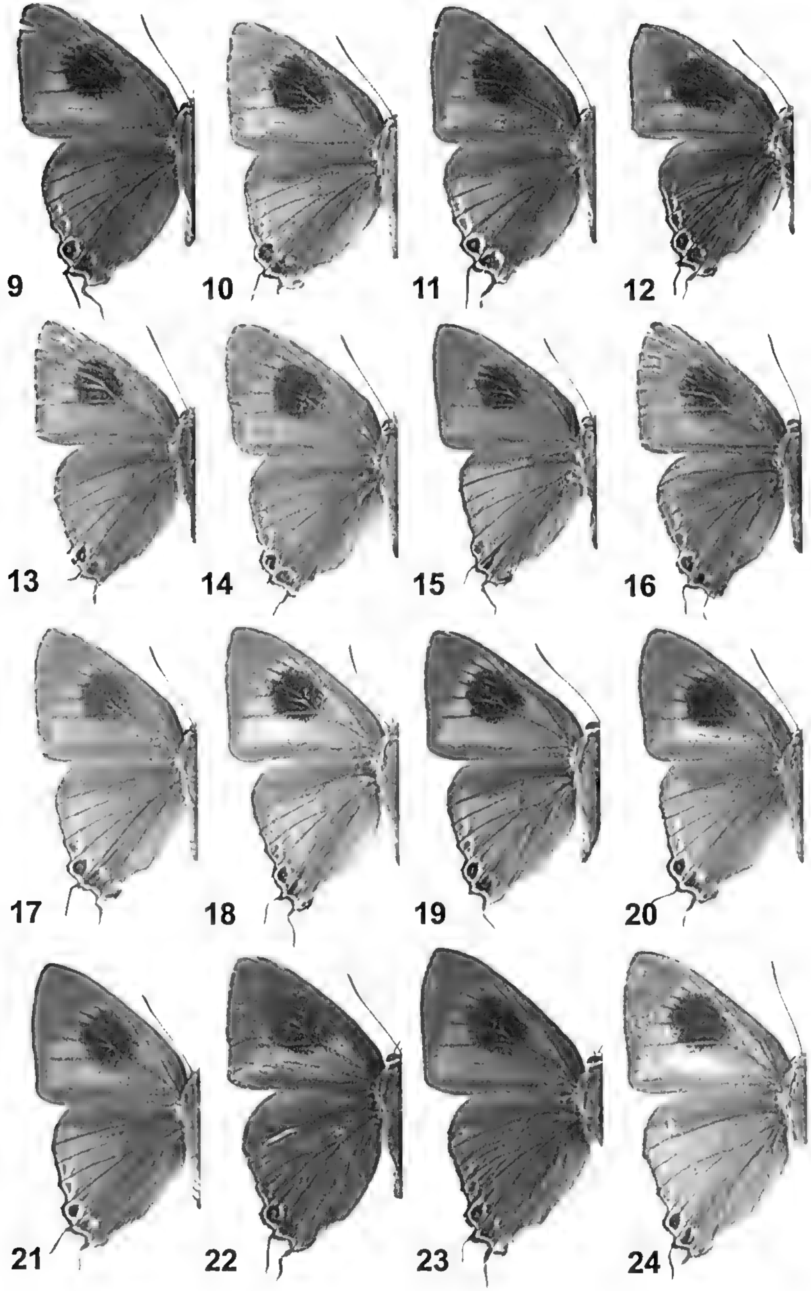

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Table 1. Proportions and percentages of the three morph types of female *H. phorbas* (318 specimens) occurring in four designated geographical zones in Queensland, Northern Territory and northern Western Australia. Months of capture (i-xii) are indicated for specimens in each morph group for each geographical zone.

Geographical zones	Proportion and percentage in each morphology group* [with months of capture]		
	Morph 1 (pale)	Morph 2 (intermediate)	Morph 3 (dark)
A: Gladstone to Cooktown	36/49 73.5% [iii-vii, x-xii]	10/49 18.4% [i, iii, v, xii]	4/49 8.1% [xii, v]
B: Cooktown to Thursday I. group	33/74 44.6% [ii-viii]	38/74 51.4% [i-viii, xii]	3/74 4% [vi-viii]
C: Torres Strait N of Thursday I.	13/107 12.1% [i-ii, iv-v, vii]	41/107 38.3% [i-ii, iv-v, vii, ix]	53/107 49.6% [i-ii, iv-vi, ix]
D: Northern Territory, Western Australia	4/71 5.6% [i, iii, v]	23/71 32.5% [i-vi, xii]	44/71 61.9% [i-vii, xii]

* The numbers of specimens of the rarer morph that were not considered for the study found in each geographical zone were: in Zone A - 4, B - 3, C - 4 and D - 6.

For all specimens examined there was no seasonal influence detected, that is no correlation between month of capture and any morphological category in any geographical zone. The size of the females examined varied within each morphological category and geographical zone (forewing lengths 14-20 mm). In summary, the review indicated that the upperside facies of female *H. p. phorbas* became progressively darker moving in a northerly direction through tropical Queensland and, in addition, specimens from the northern Torres Strait islands contained similar proportions of each morph group to the Northern Territory/Western Australia *H. p. ingura* specimens, and this trend was not related to seasons.

The review of the males from each geographical zone indicated that they had common features in all zones (Figs 9-24). In general, the uppersides were highly variable, particularly in the extent, shade and intensity of the coloured area, this colour varying from dark purple-blue through to aqua-green. The relative size of the sex brand and the extent of white scaling in the area above vein 1A+2A on the forewing, and the number of white subterminal rings on the upperside of the hind wing, were also variable. Moreover, dark purple-blue (Figs 9, 15, 19 and 23) and paler blue specimens (Figs 10, 13, 18 and 24), including specimens with white scaling in the area above vein 1A+2A of the forewing (Figs 9, 16, 20 and 22), occurred in all zones. Forewing lengths varied greatly (13-19 mm), as did the shape of the hind wings and, to a lesser extent, the forewings, but none of these features was related to any particular geographical zone. Four specimens were noteworthy in that they were

atypical of all other males examined (Appendix 2). These were: (i), Great Keppel Island, Qld, 25.xii.2002, JSB (JSBC) – very restricted upperside coloured areas, apical black ground colour of forewing meeting sex brand (forewing length 17 mm) (Fig 22); (ii), Mt White summit, Coen, Qld, 6.vii.1976, GBM (QM) – small with white scaling covering almost all the coloured areas of the forewings (14 mm); (iii), Sale R., WA, 16.v.1996, CGM (CGMC) – small with grey-blue upperside (12 mm); (iv), Yeppoon, Qld, 27.x.1924, GB (QM) – small with very dull blue upperside (13 mm).

Discussion

Hypolycaena phorbas shares an obligate relationship with the weaver or green tree ant, *Oecophylla smaragdina* (Hymenoptera: Formicinae) (Eastwood and Fraser 1999) and, consequently, the two species' distributions are closely linked (Lokkers 1986, Shattuck and Barnett 2001, Braby 2000). Lokkers (1986) studied the distribution of *O. smaragdina* in Australia and his mapped data indicated that its distribution on mainland Australia closely matched the known distribution of *H. phorbas*. He also found the ant in the intervening gulf country region, between the Northern Territory and Queensland, where *H. phorbas* has not yet been recorded.

All females of *H. phorbas* have the same dull greyish-black upperside ground colour, but the extent of the central cream forewing patch, the amount of bluish-grey scales that overlie the patch and the number and intensity of the white subterminal rings on the hind wing vary greatly, even within the same geographical zone. Despite this variation, there were distinct trends observed which strongly indicates that female *H. phorbas* forms a cline in tropical Queensland, with typical 'pale' *H. p. phorbas* predominately occurring south of Cooktown, with mostly darker specimens recorded northwards to the southern Torres Strait islands, and with mainly very dark examples, typical of *H. p. ingura*, found in northern Torres Strait. This cline is likely to extend to southern coastal Papua New Guinea, where females also have the central cream-coloured patch on the forewing highly variable in size and with dark examples known from coastal towns opposite the northern Torres Strait islands (E.D. Edwards pers. comm.).

Although this cline is evident in Queensland because of the known continuous distribution of *H. phorbas*, from Tannum Sands to northern Torres Strait, there are no collection records for this species from the gulf country between the west coast of Cape York Peninsula in Queensland and East Arnhem Land in the Northern Territory. In this particular area *O. smaragdina* is known to occur (Lokkers 1986) and, considering the diverse habitats that *H. phorbas* occurs in, its wide host range and its obligate association with *O. smaragdina*, it is highly likely that *H. phorbas* has a continuous distribution from southern coastal Papua New Guinea across Torres Strait into Queensland, and from there through the gulf country to East Arnhem Land, Darwin and northern Western Australia. With the above

evidence, and the fact that examples from northern Torres Strait and the Northern Territory/Western Australia mostly fall into the same morph group, the status of subspecies *H. p. ingura* is tenuous. Therefore, it is proposed here that *H. p. ingura* Tindale be placed as a junior synonym (syn. n.) of *H. p. phorbas* (Fabricius).

The upperside facies of all male *H. phorbas* examined were highly variable, particularly in the upperside colour and in the presence of white scaling in the forewing area above vein 1A+2A. Males from the southern end of its range at Yeppoon, referred to by Braby (2000) as being darker and duller blue on the upperside, were also recognised from other locations, even in the extreme north of the range. As a result of this variability, no distinctive feature or collection of features could be assigned to any geographical zone and no progressive trends were detected. Overall, there was no evidence found to indicate that the variation observed in males was clinal.

Oddly, the distribution of *H. phorbas* in Torres Strait is poorly documented, with Braby (2000) offering only scant information on its distribution in this region, although he presented a useful map of the region showing all the island groups. Therefore, a summary of the current known distribution of *H. phorbas* in Torres Strait is documented here. All recent collection records since the 1970s indicate that it occurs on the Thursday Island group of islands (*i.e.* Thursday, Prince of Wales, Horn and Hammond) (CGM, RBL and S.J. Johnson [SJJ] collection records, De Baar 1988, Lambkin and Knight 1983), on Moa and Badu Islands (Valentine and Johnson 1993, CGM and AIK collection records), on the small, uninhabited islands of Suarji and Getullai immediately east of Moa (De Baar 1988), on Yorke and Yam Islands in the central eastern area of the strait (JWD and AIK collection records, respectively) and in the far north of the strait near the Papua New Guinea coastline on Saibai, Boigu and Dauan Islands (AIK, CEM, JFD, PSV, RPW, SJJ, SSB and TAL collection records). Interestingly, despite extensive collecting since the early 1980s on Darnley and Murray Islands in the far east of the strait, there are still no collection records of *H. phorbas* from these two islands aside from the early 20th century records of H. Elgner (Waterhouse and Lyell 1914). In addition, *H. phorbas* is not known from neighbouring Stephens Island. Interestingly, however, since the commencement of this collecting resurgence no *O. smaragdina* obligate butterfly species, nor the ant, have been collected on Murray Island, and only *Liphyra brassolis* Rothschild (Lycaenidae) (Johnson 1983), together with *O. smaragdina* (De Baar 1988), are known from Darnley Island.

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Appendix 1

Abbreviations of specimen depositories for Appendices 1-2 and Figures 1-24 are: ANIC – Australian National Insect Collection, Canberra; CEMC – C.E. Meyer Collection, Canberra; CGMC – C.G. Miller Collection, Lennox Head; DPIFC – Department of Primary Industries and Fisheries Collection, Brisbane; JFDC – J.F. Donaldson Collection, Thornlands; JSBC – J.S. Bartlett Collection, Brisbane;

MDBC – M. De Baar Collection, Brisbane; QM – Queensland Museum, Brisbane; RPWC – R.P. Weir Collection, Darwin; SSBC – S.S. Brown Collection, Bowral; TLIKC – Joint T.A. Lambkin and A.I. Knight Collections, Brisbane.

Abbreviations of collectors recorded in Appendices 1-2 and Figures 1-24 are: AIK – A.I. Knight; CEM – C.E. Meyer; CGM – C.G. Miller; DC – D. Cook; DLH – D.L. Hancock; DW – D. Wilson; DY – D. Yeates; GB – G. Barnard; GBM – G.B. Monteith; JCO – J.C. Olive; JFD – J.F. Donaldson; JSB – J.S. Bartlett; JWCD – J.W.C. d'Apice; LRR – L.R. Ring; MDB – M. De Baar; PRS – P.R. Samson; PSV – P.S. Valentine; PW – P. Wilson; RBL – R.B. Lachlan; RPW – R.P. Weir; SRM – S.R. Monteith; SSB – S.S. Brown; TAL – T.A. Lambkin; WG – W. Graham; WHM – W.H. Miskin.

Collection data for 317 specimens of female H. phorbas *examined and placed into four geographical zones*

ZONE A. QUEENSLAND: 2 ♀♀, Allingham, ex pupa, 10.iii.1982, 25.iii.1985, PW (DPIFC); 2 ♀♀, Annan River, Cooktown, 31.v.1998, CGM (CGMC); 7 ♀♀, Cairns, 26.xii.1966 (1), 2.iv.1968 (2), 16.iv.1969 (1), 7.v.1969 (1), 28.v.1974 (2), JWCD (ANIC); 2 ♀♀, Cairns, 12.xii.1963, 17.v.1971, CGM (CGMC); 1 ♀, Cape Tribulation, 19.iv.1969, JWCD (ANIC); 2 ♀♀, Cardwell, WHM (QM); 1 ♀, Cardwell, 21-23.xi.2004, MDB (MDBC); 1 ♀, Cooktown, 20.iv.1922, GB (QM); 1 ♀, Cooktown, 12.v.1992, JWCD (ANIC); 1 ♀, Cooktown, 7.v.1999, CGM (CGMC); 1 ♀, Crystal Ck, 41 km S of Ingham, 24.ii.2002, CGM (CGMC); 1 ♀, Ellis Beach, 3.xii.1964, CGM (CGMC); 1 ♀, Flying Fish Point, 24.iv.1987, AIK (TLIKC); 7 ♀♀, Gordonvale, 17.iv.1992 (1), 11.iv.1994 (1), 12.vi.1994 (2), 5.i.1995 (2), 8.vii.1998 (1), CEM (CEMC); 1 ♀, larva coll. Home Hill, 30.i.1986, PRS (DPIFC); 1 ♀, Lake Placid, Cairns, 21.xii.1963, CGM (CGMC); 1 ♀, Lucinda, 26.ii.2002, CGM (CGMC); 1 ♀, Port Douglas, 13.v.1973, CGM (CGMC); 1 ♀, larva coll. Port Douglas, 30.iv.1985, PRS (TLIKC); 1 ♀, S. of Port Douglas, 21.iii.1975, MDB (MDBC); 1 ♀, Saunders Beach, 17.iv.1992, LRR (CEMC); 1 ♀, same data except (RPWC); 3 ♀♀, Shute Harbour, 13.xii.1966 (2), 29.iii.1968 (1), JWCD (ANIC); 1 ♀, Townsville, 4.v.1983, AIK (TLIKC); 1 ♀, Townsville, 18.v.1983, SSB (SSBC); 2 ♀♀, Townsville, 10.v.1984, 20.xi.1984, PSV (TLIKC); 1 ♀, Trinity Beach, 20.v.1994, JCO (CEMC); 1 ♀, Trinity Park, 26.iv.1995, TAL (TLIKC); 1 ♀, West Hill Ck, 50 km S of Sarina, 11.xii.1983, MDB (MDBC); 2 ♀♀, Second Bch, Yarrabah Pen., 29.xi.2004, MDB (MDBC); 2 ♀♀, Yeppoon, 27.x.1924, 28.x.1924, GB (QM); 2 ♀♀, Yeppoon, 12.iii.1987, AIK (TLIKC).

ZONE B. QUEENSLAND: 1 ♀, Bamaga, 19-20.vi.1992, AIK (TLIKC); 3 ♀♀, Bamaga, 30.vii.1998 (2), 7.vii.1998 (1), CEM (CEMC); 1 ♀, 11 km S of Batavia Downs, 30.vi.1975, GBM (QM); 8 ♀♀, Cape York, 26.iv.1969 (1), 29.iv.1969 (1), 11.vi.1973 (3), 21.v.1974 (1), 7-13.iv.1977 (1), 22.v.1992 (1), JWCD (ANIC); 1 ♀, Cape York, 6.vi.1928, GB (QM); 1 ♀, Capsize Ck, 64 km N of Archer R., 17.vii.1975, GBM (QM); 3 ♀♀, 15 km W of Captain Billy Ck, 5-12.ii.1976, GBM (QM); 1 ♀, 43 km NW of Cooktown, 13.viii.1977, CGM (CGMC); 2 ♀♀, 23 km N of Cooktown, 27.iv.1999, 28.iv.1999, CGM (CGMC); 1 ♀, 26 km W of Fairview Station, Coen Rd, 24.vii.1977, CGM (CGMC); 1 ♀, Hibberd Pt, Weipa, 3-5.ii.1976, GBM (QM); 1 ♀, 7 km N of Hopevale, 18.vii.1975, GBM & SRM (QM); 1 ♀, Iron Range, 10.viii.2001, AIK (TLIKC); 2 ♀♀, Iron Range, 24.viii.1999, 10.vi.1982, CGM (CGMC); 1 ♀, Iron Range, 4-12.vii.1995, JWCD (ANIC); 1 ♀, Iron Range, 7.vii.1999, RPW (RPWC);

1 ♀, Kowanyama, 10.i.1977, DLH (QM); 1 ♀, Stock Ck, 15 km E of Kowanyama, 13.i.1977, DLH (QM); 3 ♀♀, Lockerbie, 23.iv.-1.v.2004, CEM (CEMC); 1 ♀, Lockerbie, 10.v.2003, SSB (SSBC); 1 ♀, 22 km N of Moreton, 2.vii.1975, GBM (QM); 1 ♀, Musgrave, 23.v.1998, CGM (CGMC); 1 ♀, Normanby River crossing, 12.v.1992, JWCD (ANIC); 1 ♀, Rocky Pt, Weipa, 3-5.ii.1976, GBM (QM); 1 ♀, Stewart R, 6 km W of Port Stewart, 19-20.vii.1975, GBM (QM); 6 ♀♀, Thursday Island, Torres Strait, 22.vii.1983 (1), 24.vii.1983 (2), 16-17.vi.1992 (1), 10.iv.2000 (1), 22.v.2001 (1), AIK (TLIKC); 17 ♀♀, Thursday I., 24-26.iii.2000 (2), 13.v.2001 (1), 24.iv.2001 (2), 4-5.v.2002 (1), 8.v.2002 (4), 9.v.2002 (1), 10.v.2002 (1), 13.v.2002 (1), 18.v.2002 (1), 20.v.2002 (1), 23.v.2002 (1), 26.v.2002 (1), CEM (CEMC); 2 ♀♀, Thursday I., 30.iii.-2.iv.1984, JWCD (ANIC); 3 ♀♀, Thursday I., 3-4.v.2002, RPW (RPWC); 3 ♀♀, Thursday I., v.2001, SSB (SSBC); 5 ♀♀, Thursday I., 23.vii.1983 (1), 12-15.iv.1992 (2), 12.xii.1993 (1), 25.iv.1995 (1), TAL (TLIKC).

ZONE C. QUEENSLAND (TORRES STRAIT): 1 ♀, airstrip, Badu Island, 11.vii.1977, CGM (CGMC); 5 ♀♀, Boigu Island, 8-9.iv.1992, AIK (TLIKC); 3 ♀♀, Boigu I., 8-9.iv.1992, TAL (TLIKC); 1 ♀, Boigu I., 12.iv.1992, TAL (MDBC); 21 ♀♀, Dauan Island, 2.iv.2001 (2), 4.iv.2001 (2), 14.iv.2001 (1), 21.iv.2001 (1), 30.iv.2001 (1), 2.v.2001 (2), 3.v.2001 (3), 13.v.2001 (1), 14.v.2001 (1), 27.i.2004 (1), 28.i.2004 (2), 29.i.2004 (3), 30.i.2004 (1), AIK (TLIKC); 36 ♀♀, Dauan I., 11-17.iv.2001 (28), 19.iv.2001 (1), 21.iv.2001 (1), 27.iv.2001 (1), 28.iv.-2.v.2002 (4), 1.v.2002 (1), CEM (CEMC); 6 ♀♀, Dauan I., 3-4.v.2002, RPW (RPWC); 2 ♀♀, Dauan I., 19.iv.2001, 25.v.2001, CEM (SSBC); 1 ♀, Dauan I., 26.iv.2002, SSB (SSBC); 6 ♀♀, Dauan I., 17.ii.2004 (1), 18.ii.2004 (1), 19.ii.2004 (1), 21.ii.2004 (3), TAL (TLIKC); 6 ♀♀, Eet Hill, Moa Island, 9-13.vii.1977 (4), 10.vii.1977 (1), 11.vii.1977 (1), CGM (CGMC); 3 ♀♀, St Pauls, Moa Island, 8.vii.1977, 14-17.vii.1977, 17.vii.1977, CGM (CGMC); 1 ♀, Moa Island, 27.v.1924, GB (QM); 3 ♀♀, Moa I., 9-13.vii.1977, GBM (QM); 1 ♀, Moa I., 4.i.1975, RBL (SSBC); 8 ♀♀, Saibai Island, 10.iv.2001 (1), 19.iv.2001 (1), 7.v.2001 (2), 8.v.2001 (1), 22.v.2001 (1), 5.ii.2004 (2), AIK (TLIKC); 1 ♀, Saibai I., 2.v.2002, SSB (SSBC); 3 ♀♀, Saibai I., 28.ix.1992 (2), 22.ii.1994 (1), TAL (TLIKC); 2 ♀♀, Yam Island, 18-20.vii.1977, GBM (QM); 1 ♀, Yam I., 11-12.vi.1992, AIK (TLIKC); 1 ♀, Yorke Island, 15.vi.1973, JWCD (ANIC).

ZONE D. NORTHERN TERRITORY: 1 ♀, 10 km E of Adelaide R., 16.iv.1995, CEM (SSBC); 2 ♀♀, Alyangula, 17-20.v.1982, 19-21.v.1982, JWCD (ANIC); 11 ♀♀, Berrimah Research Stn, 10-20.i.2003, RPW (RPWC); 3 ♀♀, Bustard Island, 21.v.1982, JWCD (ANIC); 3 ♀♀, same data except CGM (CGMC); 1 ♀, Channel Island, 2.iv.1995, CEM (CEMC); 1 ♀, Casuarina, 14.ii.1992, SSB (SSBC); 1 ♀, Darwin, 2.vii.1973, JWCD (ANIC); 1 ♀, Darwin, 6.ii.1987, CGM (CGMC); 3 ♀♀, Darwin, 20.iv.1991 (1), 8.ii.1992 (2), DW (RPWC); 10 ♀♀, Darwin, ex larva, 1-22.iii.2003, RPW (TLIKC); 4 ♀♀, Darwin, ex larva, 6-8.ii.2003, RPW (SSBC); 1 ♀, 130 km S of Darwin, 1.v.1989, RPW (RPWC); 1 ♀, Gunn Pt, 26.iv.1991, SSB (SSBC); 1 ♀, Ininowinyin Gorge, via Oenpelli, 20.iv.1922, GB (QM); 1 ♀, Kakadu, 25-26.v.1986, JWCD (ANIC); 5 ♀♀, Leanyer, 11.xii.1998 (1), 16.xii.1998 (1), 1.i.2000 (2), 10.iii.2003 (1), RPW (RPWC); 1 ♀, Marrakai Rd, 70 km S of Darwin, 29.iii.1992, DW (RPWC); 14 ♀♀, Palmerston, 2.iv.1995 (1), 16.iv.1995 (1), 18.iv.1995 (2), 19.iv.1995 (1), 22.iv.1995 (2), 23.iv.1995 (3), 26.iv.1995 (1), 28.iv.1995 (2), 25.v.1995 (1), CEM (CEMC); 1 ♀, Palmerston, 24.iv.1995, CEM (SSBC); 5 ♀♀, Palmerston, 14.ii.1992, SSB (SSBC); 1 ♀, Radon Ck, 14-16.vii.1979, GBM & DC (QM); 2 ♀♀, Wessel, 26.vi.1973 JWCD (ANIC).

WESTERN AUSTRALIA: 1 ♀, 37 km S of Kalumburu 3.vi.1990, CGM (CGMC); 1 ♀, Pascoe Island, West Kimberley, 30.v.1990 DY (QM).

Appendix 2

Collection data for 123 specimens of male H. phorbas *examined*

QUEENSLAND: 2 ♂♂, Allingham, 10.iii.1982, 25.iii.1985, PW (DPIFC); 4 ♂♂, Bamaga, 27.vii.1983, 19-20.vi.1992, 3-8.v.1994 (2), AIK (TLIKC); 1 ♂, Bamaga, 15.iv.1995, TAL (TLIKC); 2 ♂♂, Boigu I., Torres Strait, 8-9.iv.1992, AIK (TLIKC); 1 ♂, same data except TAL (TLIKC); 2 ♂♂, Cairns, 2.iv.1968, AD (ANIC); 4 ♂♂, Cairns, 16.iv.1969, 25.xii.1969, 5.x.1970, 1.xii.1971, AWH (ANIC); 1 ♂, Cairns, 28.v.1974, JWCD (ANIC); 3 ♂♂, Cape York, 29.iv.1969, 6.v.1969, 21.x.1979, JWCD (ANIC); 1 ♂, Daintree, 16.v.1988, AIK (TLIKC); 14 ♂♂, Dauan I., Torres Strait, 1.iv.2001, 3.iv.2001, 4.iv.2001, 10.iv.2001, 14.iv.2001, 2.v.2001, 9.v.2001, 10.v.2001, 11.v.2001 (2), 14.v.2001, 16.i.2004, 28.i.2004, 29.i.2004, AIK (TLIKC); 1 ♂, Dauan I., 4.iv.1990, JFD (JFDC); 23 ♂♂, Dauan I., 17.ii.2004 (3), 18.ii.2004 (3), 19.ii.2004 (2), 21.ii.2004 (15), TAL (TLIKC); 1 ♂, same data except (JFDC); 3 ♂♂, Flinders I., 5.i.1973, JWCD (ANIC); 1 ♂, Great Keppel I., 25.xii.2002, JSB (JSBC); 3 ♂♂, Flying Fish Point, 25.iv.1982, 14.iv.1987, 21.iv.1987, AIK (TLIKC); 1 ♂, Hull Heads, 27.iv.1978, TAL (DPIFC); 1 ♂, Iron Range, 26.v.-8.vi.1982, JWCD (ANIC); 2 ♂♂, Moa I., Torres Strait, 15.iv.2001, 16.iv.2001, AIK (TLIKC); 1 ♂, Mt White summit, Coen, 6.vii.1976, GBM (QM); 3 ♂♂, Portland Roads, 19.xii.1966, 2.v.1969 (2), JWCD (ANIC); 3 ♂♂, Saibai I., Torres Strait, 28.ix.1992 (2), 14.iii.2001, TAL (TLIKC); 6 ♂♂, Saibai I., 10.iv.2001, 6.v.2001 (2), 7.v.2001, 15.ii.2004 (2), AIK (TLIKC); 1 ♂, Shute Harbour, 1.i.1967, RD (ANIC); 1 ♂, Thursday I., vii.1983, AIK (TLIKC); 2 ♂♂, Thursday I., 23-31.vii.1983, 12-15.iv.1992, TAL (TLIKC); 7 ♂♂, Thursday I., 22.vi.1973 (5), 2.iv.1984 (2), JWCD (ANIC); 4 ♂♂, Townsville, 20.xi.1984, PSV (TLIKC); 3 ♂♂, Yeppoon, 27.x.1924, GB (QM); 1 ♂, Yeppoon, 3-4.i.1979, TAL (DPIFC); 1 ♂, Yeppoon, 12.v.1995, AIK (TLIKC); 1 ♂, Yorke I., Torres Strait, 16.vi.1973, JWCD (ANIC); 1 ♂, Yule Pt, 30.iv.1978, TAL (DPIFC).

NORTHERN TERRITORY: 1 ♂, Bustard I., 21.v.1982 JWCD (ANIC); 3 ♂♂, Darwin, v.1983, WG (DPIFC); 6 ♂♂, Darwin, larva collected, 1-22.iii.2003, RPW (TLIKC); 1 ♂, Darwin, 18-28.v.1986, JWCD (ANIC); 1 ♂, East Point, Darwin, 28.iv.1993, AIK (TLIKC); 1 ♂, Point Stuart, 6.vii.1973, JWCD (ANIC); 1 ♂, Robin Falls, 3.vii.1973, JWCD (ANIC); 1 ♂, Rocky Bay, 3-7.v.1992, JWCD (ANIC); 2 ♂♂, Cape Wessel, 26.vi.1973, JWCD (ANIC).

WESTERN AUSTRALIA: 1 ♂, Kalumburu, 13.v.1991, JWCD (ANIC); 1 ♂, 37 km S of Kalumburu, 12.v.1991, CGM (CGMC); 1 ♂, Sale R., 16.v.1996, CGM (CGMC).

NEW SPECIES AND SUBSPECIES OF *RAPALA* MOORE AND *DEUDORIX* HEWITSON (LEPIDOPTERA: LYCAENIDAE) FROM EAST TIMOR

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Abstract

Rapala aquamarina sp. n., *R. christopheri* sp. n., *R. manea odemo* subsp. n., *R. varuna tacita* subsp. n. and *Deudorix epijarbas timorleste* subsp. n. are described and figured from East Timor. They are compared with related *Rapala* Moore and *Deudorix* Hewitson taxa from the Indo-Pacific region.

Introduction

Rapala Moore and *Deudorix* Hewitson are the two largest Indo-Pacific genera of the lycaenid tribe Deudorigini. The genus *Rapala* contains several dozen species that are essentially Southeast Asian in distribution, weakly extending into the Palearctic and Australian regions. Within the Indo-Pacific region, Corbet and Pendlebury (1978, 1992) recorded 14 species of *Rapala* from Peninsula Malaysia, which were revised by Corbet (1939). Seki *et al.* (1991) listed 12 species from Borneo, while only six species are known from Sulawesi, east of Wallace's Line (Vane-Wright and de Jong 2003). D'Abrera (1971, 1990) listed only *R. varuna* (Horsfield) from the Australian region, but did not list *R. varuna* or any *Deudorix* species from Timor. *Deudorix* is widely distributed in the Afrotropical, Oriental and Australian regions (Braby 2000). To date, no species of either *Rapala* or *Deudorix* is known or has been recorded from Timor. During a recent visit to East Timor by one of us (DL, in conjunction with Mark Lane) in 2004, four *Rapala* and one *Deudorix* species were collected, which are discussed below.

Known species of *Rapala*, as in the related genus *Deudorix*, constitute both 'blue' and 'orange' species. All of the new *Rapala* taxa described here represent 'blue' species, except one, which clearly belongs to a group with several representatives in Sulawesi and western Indonesia. The 'orange' species of *Rapala* were revised by Takanami (1992), who earlier (1989) proposed a number of new synonyms and lectotypes for this group. Takanami (1998) illustrated all known Southeast Asian species of *Rapala*, recognising 28 for the region.

The fauna of East Timor is poorly known, due mainly to extremely limited access over the past thirty years. The recent independence of East Timor has created an opportunity to gain access and observe some of the Lepidoptera fauna there. Many detailed descriptions of Indo-Pacific *Rapala* and *Deudorix* species have been published previously - where appropriate, the following descriptions serve to highlight each species' distinguishing features.

The following collection acronyms have been used:: ANIC – Australian National Insect Collection, Canberra; DLC – Private collection of D. A. Lane, Atherton; CJMC – Private collection of C. J. Müller, Sydney.

***Rapala aquamarina* sp. n.**

(Figs 1-4, 19)

Types. Holotype ♂, EAST TIMOR: 5 km NW Bobonaro, 9°00'35"S, 124°17'E, 16.i.2004, D.A. & M.D. Lane (in ANIC). *Paratypes.* 1 ♂, 1 ♀, same data as holotype, but dated 15, 16.i.2004 (in DLC); 1 ♂, same data as holotype but dated 15.i.2004 (in CJMC).

Description. Male (Figs 1-2). Forewing length 15 mm. Head and eyes brown. Thorax and abdomen aquamarine blue. Forewing upperside broadly black, from basal 1/3 to tornus deep aquamarine blue; sex mark broad, light brown. Hindwing upperside broadly deep aquamarine blue, termen narrowly edged black; linear tail black, white tip; tornal lobe brown, a black central spot with a black outer ring and blue scaling overlay. Forewing underside broadly brown, termen edged darker brown; a faint subterminal band runs parallel to termen; a broad brown submedian band, edged white, extends from costa, directed towards inner tornus but not reaching dorsum; a short brown band transverses end of cell. Hindwing underside broadly brown, dorsum area slightly darker brown; a broad dark brown band, edged white, extends from costa directed towards tornus for 3/4, then angling towards dorsum; white edging in dorsal area more pronounced; tornal lobe black; faint tornal eyespot black, edged white terminally; a faint subterminal brown line extends from near apex to tornal eyespot.

Male genitalia (Fig 19, Genitalia slide ANIC 18572). Genitalic ring oval; sociuncus U-shaped anteriorly in dorsal view, with prominent hump at base of saddle, sociuncus rounded laterally; brachium long, thick but tapering apically, strongly dipping downwards; valvae squat, bifurcated with rounded apices; aedeagus elongate, flattened apically, canoe-shaped with three spine-adorned folds.

Female (Figs. 3-4). Forewing length 15 mm. Head and body pale brown. Wings broader and more rounded than in male; forewing upperside broadly pale blue, termen and apex narrowly black; a very pale brown central area extends from just beyond cell to CuA_2. Hindwing upperside broadly pale blue, tornal lobe and linear tail as in male. Underside as in male, but much paler light brown ground colour.

Etymology. Named after the distinct aquamarine colouration of the male upperside, which contrasts noticeably with the black forewing apex.

Comments. Rapala aquamarina is very distinctive, the male with an upperside wing pattern, colouration and forewing sex mark reminiscent of an unrelated Oriental lycaenid, *Tajuria mantra* (C. & R. Felder). In particular, the lustrous, aquamarine colour of the male upperside is unique among

described *Rapala* species. The undersides of both wings bear a broader median band than any other 'blue' *Rapala*, and the distinctive white basal bordering to these bands is also unusual.

The genitalia of *R. aquamarina* show similarities to both *R. varuna* (Horsfield) and *R. manea* (Hewitson), as well as to *R. rhoecus* de Niceville. The sociuncus of all these taxa are very similar when viewed dorsally. The valvae of *R. aquamarina* are more squat, with thicker apices than other 'blue' *Rapala* species examined, and the aedeagus is particularly distinctive, being canoe-shaped apically and possessing three folds bearing numerous regularly spaced spines on their crests.

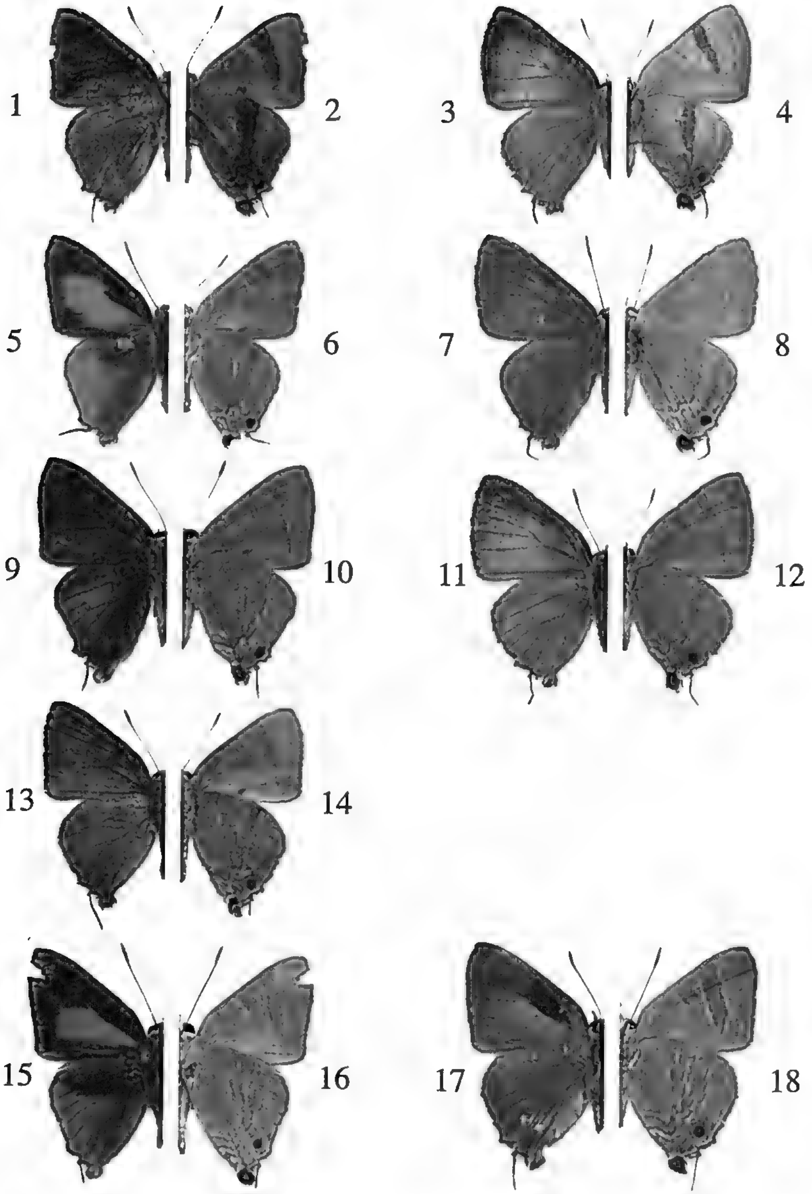
Rapala christopheri sp. n.
(Figs 5-8, 20)

Types. Holotype ♂, EAST TIMOR: 10 km SW Dili, Mangroves, 22.i.2004, D.A. & M.D. Lane (in ANIC). *Paratypes:* 1 ♀, same data as holotype (in ANIC); 7 ♂♂, 7 ♀♀, same data as holotype, but 7, 22.i.2004 (in DLC); 4 ♂♂, 4 ♀♀, same data as holotype, but 7, 22.i.2004 (in CJMC).

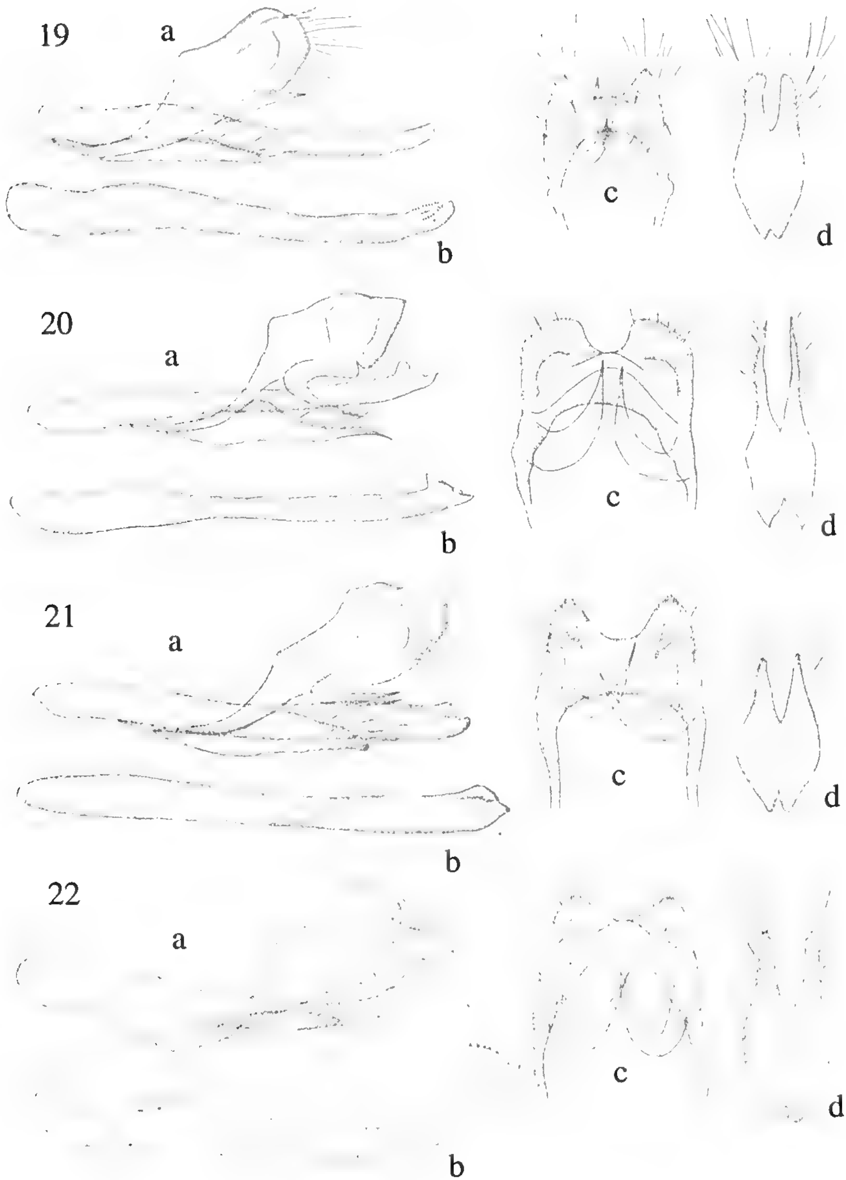
Description. Male (Figs 5-6). Forewing length 14-17 mm. Forewing upperside broadly black extending along costa, termen and dorsum; a broad central area rich orange that extends basally along and below cell, but not reaching termen. Hindwing upperside basally black and extending along dorsum to tornus and costa, but not reaching apex; outer 2/3 broadly rich orange extending to termen; termen thinly edged black; linear tail black, white tip; tornal lobe orange, with black centre, distally edged white; a distinct pale brown sex mark above cell. Forewing underside broadly pale brown, inner central area (mirror image of upperside rich orange) very pale brown; a dark brown postmedian band extends from costa in a broad arc towards, but not reaching, inner tornus; a small brown transverse bar extends across outer cell; a faint brown subterminal band runs parallel to termen. Hindwing underside broadly brown; a brown postmedian band extends from costa, directed for 2/3 towards but not reaching tornus, then angling to dorsum; that section of band meeting dorsum pale yellow brown, edged white; a subterminal brown band extends parallel to termen from apex to eyespot; eyespot centrally black, edged pale orange basally, edged white terminally; dorsal lobe black, edged white terminally.

Male genitalia (Fig 20, Genitalia slide ANIC 18573). Genitalic ring oval; sociuncus U-shaped anteriorly in dorsal view, sociuncus squared laterally, pointed at apex; brachium long, thick but tapering apically, strongly dipping downwards; valvae narrow, bifurcated both posteriorly and anteriorly, with very long, tapered apices; aedeagus elongate, humped anteriorly and with subtle, teeth-like processes at apex.

Female (Figs 7-8). Forewing length 16-18 mm. Wings broader and more rounded than in male. Forewing and hindwing upperside broadly grey-brown,



Figs 1-18. *Rapala* and *Deudorix* spp., upper and undersides. (1–4) *Rapala aquamarina* sp.n.: (1-2) male; (3-4) female. (5-8) *Rapala christopheri* sp.n.: (5-6) male; (7-8) female. (9-12) *Rapala manea odemo* ssp.n.: (9-10) male; (11-12) female. (13-14) *Rapala varuna tacita* ssp.n., male. (15-18) *Deudorix epijarbas timorleste* ssp.n.: (15-16) male; (17-18) female.



Figs 19-22. Male genitalia of *Rapala* spp. (a) Genitalia with left valva removed, lateral view, 20X; (b) aedeagus, lateral view, 22X; (c) sociuncus, dorsal view, 20X; (d) valvae, ventral view, 20X. (19) *R. aquamarina*, genitalia slide ANIC 18572; (20) *R. christopheri*, genitalia slide ANIC 18573; (21) *R. manea odemo,* genitalia slide ANIC 18574; (21) *R. varuna tacita,* genitalia slide ANIC 18575.

noticeably darker along forewing costa and termen, and along upperside veins. Hindwing tornal lobe centrally black, edged pale orange basally, edged white terminally; linear tail black, white tip. Underside as in male, but basal colour paler light brown.

Etymology. Named after Christopher Lane of Townsville, who was coerced to endure many entomological excursions during his school years.

Comments. Rapala christopheri is a further 'orange' species, with broad median bands on the underside of the wings in both sexes. Additionally, the white discocellular markings on the underside of both wings and the yellowish submarginal band on the hindwing underside allow separation from other described 'orange' *Rapala* taxa. Both sexes of the Indo-Malayan *R. dieneces* (Hewitson), *R. damona* Swinhoe and *R. iarbus* Fabricius are similar to *R. christopheri* on the upperside, but each are easily distinguished from the latter: *R. dieneces* has an ochraceous yellow-brown underside ground colour (grey-brown in *R. christopheri*) and less pointed forewings in both sexes; both *R. damona* and *R. dieneces* have reduced reddish areas in the upperside of the wings, while *R. iarbus* has more extensive red colouration. However, the most distinctive difference between *R. christopheri* and these species is the much broader underside bands, which on the forewing are also more strongly bowed and displaced basally. *R. christopheri* is the most southeasterly known of the 'orange' *Rapala* species.

The male genitalia of *R. christopheri* are similar in form to other 'orange' *Rapala* species, especially in the strongly bifurcated posterior end of the valvae. The sociuncus of *R. christopheri* is close to that of *R. enipeus* Staudinger, while the valvae are most similar to those of *R. dieneces*. No described species of *Rapala* has such finely tapered valva apices as in *R. christopheri.*

***Rapala manea odemo* subsp. n.**

(Figs 9-12, 21)

Types. Holotype ♂, EAST TIMOR: 5 km NW Bobonaro, 9°00'35"S, 125°17'E, 14.i.2004, D.A. & M.D. Lane (in ANIC). *Paratypes.* 1 ♀, same data as holotype (in ANIC); 6 ♂♂, 5 ♀♀, same data as holotype, but 14, 16.i.2004; 1 ♂, Bobonaro, 1000 m, 9 00'08"S, 125 19'25"E, 11.i.2004, D.A. & M.D. Lane (all in DLC); 2 ♂♂, 4 ♀♀, same data as holotype, but dated 14, 16, 20.i.2004 (in CJMC).

Description. Male (Figs 9-10). Forewing length 16-17 mm. Forewing upperside broadly dark blue, apex and termen narrowly black; a distinct trident sex mark straddles M_3, CuA_1 and CuA_2. Hindwing upperside broadly dark blue, tornal area edged white; tornal lobe black centre, edged white distally, with pale orange patch basally; linear tail black, white tip. When viewed obliquely, the lower forewing (below trident sex mark) and outer 2/3 of hindwing are rich iridescent blue. Forewing underside grey-brown; postmedian band narrow, darker brown, edged white (more distinctly

apically); darker brown transverse band, edged white, across apex of cell. Hindwing underside grey-brown, postmedian and median band darker brown, edged white; where postmedian band meets dorsum it is edged white with iridescent green overlay; a second iridescent green line from dorsum to just above tornal lobe; tornal lobe black, edged white distally; eyespot black, with basal orange brown patch, edged white distally; linear tail black, white tip.

Male genitalia (Fig 21, Genitalia slide ANIC 18574). Genitalic ring oval; tegumen with prominent sharp crown laterally; sociuncus U-shaped anteriorly in dorsal view, with pointed apices, rounded laterally; brachium long, thick but tapering apically, strongly dipping downward; valvae pear-shaped, bifurcated both posteriorly and anteriorly, with long, sharp apices; aedeagus elongate, uniform thickness along entire length, with deep apical suture.

Female (Figs 11-12). Wings broader and more rounded than in male. Forewing length 17 mm. Forewing upperside broadly light blue; apex and termen darker blue-black. Hindwing upperside broadly light blue, termen narrowly edged black; tornal lobe and linear tail as in male. Underside similar to male, but basal colour browner.

Etymology. Named after the district of Odemo, centred on the limestone outcrop areas where this and many other species were encountered.

Comments. R. manea odemo is distinctive in having narrower wings than other described subspecies, especially in the male which possesses very pointed forewings. Additionally, the blue upperside is much lighter and more sombre coloured, giving the trident sex mark in the postmedian area of the male forewing a starker contrast. When viewed obliquely, the iridescent sheen in also much less violet than in other subspecies. On the underside the ground colour is dull grey (pearly-grey in most other subspecies) and the white median band on both wings is more contrasting.

The male genitalia of *R. manea odemo* are also distinctive when compared with described subspecies of *R. manea* from Southeast Asia, the valvae being more pear-shaped and acute. The sociuncus apices are more sharply pointed than in other subspecies and the aedeagus is simple, lacking the bulbous anterior end seen in other subspecies examined.

Rapala varuna tacita **subsp. n.**
(Figs 13-14, 22)

Type. Holotype ♂, EAST TIMOR: Bobonaro 1000 m, 9°00'08"S, 125°19'25"E, 8.i.2004, D.A. & M.D. Lane (in ANIC).

Description. Male (Figs 13-14). Forewing length 16 mm. Forewing upperside broadly rich blue, termen narrowly edged black. A distinct black sex mark patch at end of cell. Hindwing upperside broadly rich blue, termen narrowly edged black; linear tail black, white tip; tornal lobe black, with a basal

orange-brown patch, distally edged white. Forewing underside as in other subspecies, but ground colour paler grey-brown, without any suffusion of darker colour; eyespot black, basally edged orange; tornal lobe black, edged white distally, edged pale orange basally; a pale blue patch lies between tornal lobe and eyespot.

Male genitalia (Fig 22, Genitalia slide ANIC 18575). Genitalic ring oval; tegumen with prominent crown laterally; sociuncus U-shaped anteriorly in dorsal view, rounded laterally; brachium long, thick but tapering apically, strongly dipping downward; valvae bifurcated posteriorly and with long, rounded apices; aedeagus elongate, bulbous posteriorly and with long, 'tongue-like' process at apex.

Female. Unknown.

Etymology. The name *tacita* refers to such a wide-ranging species having been overlooked on the island of Timor for such a long period of time. Translates to being understood, without being stated.

Comments. This subspecies is readily separable from other described subspecies of *R. varuna* by its very light blue ground colour on the upperside of both wings in the male. The sex brand is more restricted and the underside ground colour is a more uniform medium grey-brown than in other subspecies, which are generally darker and suffused with purple.

The male genitalia of this subspecies are similar to those of other *R. varuna* subspecies examined, the aedeagus bearing the distinctive apical tongue, characteristic of this species. The apex of the aedeagus is strongly bent upwards, a character not as pronounced in other subspecies of *R. varuna* examined.

Deudorix epijarbas timorleste **subsp. n.**
(Figs 15-18)

Types. Holotype ♂, EAST TIMOR: 5 km NW Bobonaro, 9°00'35"S, 125°17'E, 15.i.2004, D.A. & M.D. Lane (in ANIC). *Paratypes.* 1 ♀, same data as holotype (in ANIC); 2 ♂♂, 2 ♀♀, same data as holotype, but dated 15, 16.i.2004 (in DLC).

Description. Male (Figs 15-16). Forewing length 18 mm. Forewing upperside broadly black along costa, termen and dorsum. Inner central area below cell rich orange red; some orange red areas straddling and below anal vein. Hindwing upperside basally black for 1/3 and extending across to apex; outer 2/3 rich orange red, veins dusted with black scaling; tornal lobe orange, black center, edged black with white fringe distally; a green spot at tornus in upper tornal lobe; linear tail black, white tip. Forewing underside dark brown, postmedian band darker brown, edged white; dark transverse band at end of cell edged white; a faint subterminal dark brown band, faintly edged white terminally. Hindwing underside dark brown; median and postmedian dark brown bands edged white; white edging more pronounced at dorsum; tornal

lobe black, faintly edged white; eyespot black, edged by an outer orange ring; an iridescent light green band above terminal lobe.

Female (Figs 17-18). Wings broader and rounder than in male. Forewing length 18 mm. Forewing upperside broadly dark brown, costa and apex darker brown; a central area for inner 1/3 below cell orange-brown. Hindwing upperside broadly dark brown; a series of orange-brown spots (variable in number and size) extends along termen from tornus; tornal lobe orange-brown, black central spot, edged black with outer white fringe; linear tail black, white tip. Underside as in male; orange ring to eyespot broader than in male.

Etymology. Named from one of the Tetun names for East Timor – Timor Leste, also referred to as Timor Lorosae.

Comments. *D. epijarbas* (Moore) is widely distributed from India and Taiwan, through Indonesia to New Guinea, northeastern Australia and the islands of the southwestern Pacific (Braby 2000). The status of some of these populations is uncertain and a revision of this and related Indo-Pacific species is needed. Compared with described subspecies of *D. epijarbas* from Borneo, Sulawesi, Maluku, New Guinea and Australia, the three collected males of *D. epijarbas timorleste* are a richer orange-red, with reduced areas of red, especially below the forewing anal vein. The three collected females all have a broad central forewing area and hind wing areas of orange-brown, both features infrequently and only faintly indicated in other subspecies.

Discussion

The 'blue' and 'orange' *Rapala* taxa in the Indo-Pacific appear to form two distinctive groups, separable by their external facies and male genitalia. The structure of the sociuncus, valvae and aedeagus emphasise this grouping. In the blue species of *Rapala*, the sociuncus is fairly constant, being strongly U-shaped when viewed dorsally, while it is rounded apically in lateral view. Similarly, the valvae are similar in all species examined and are generally pear-shaped with thickened apices. The anterior end of the aedeagus is highly diagnostic among the blue *Rapala* taxa. In *R. aquamarina* the apex of the aedeagus is flattened laterally and is distinctive in its canoe-shape, bearing folds with multiple spines, unlike other *Rapala* genitalia examined. *R. manea*, *R. varuna* and *R. rhoecus* appear related to *R. aquamarina* but the males of these taxa are all lustrous purple-blue above and the forewing sex mark is trident in form, while that of *R. aquamarina* is a circular patch of differently coloured scales.

Male genitalia of the orange *Rapala* species also reflect a distinct grouping. In these taxa, the valvae are strongly bifurcated, both posteriorly and anteriorly, but the form of the generally long apices is most diagnostic. In particular, these are very fine and tapered in *R. christopheri*. In lateral view, the shape of the sociuncus in Indo-Pacific orange *Rapala* taxa are distinctive

in that the posterior 'face' is very straight, giving a pointed appearance to the sociuncus apex. With the exception of an undescribed orange *Rapala* species from the Moluccas (CJMC), all taxa have strongly U-shaped sociuncus when viewed dorsally. In all orange *Rapala* genitalia examined, the apex of the aedeagus bears variably pronounced teeth, which are bent backwards, and the tip of the aedeagus is more sharply pointed than in blue *Rapala* taxa.

The mangrove habitat of *R. christopheri* is reminiscent of *R. cowani* Corbet from Singapore, Peninsula Malaysia and Borneo. However, *R. cowani* appears more closely related to the Sulawesi endemic *R. ribbei* Rober in its morphological characters. *R. ribbei*, *R. enipeus* Staudinger and *R. dioetas* (Hewitson) were all taken on several occasions by one of us (CM) in intertidal forest bordering mangroves at various localities in Sulawesi.

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FIELD OBSERVATIONS ON THE ECOLOGY OF THE GOLDEN SUN MOTH, *SYNEMON PLANA* WALKER (LEPIDOPTERA: CASTNIIDAE)

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Abstract

Surveys for the distribution and relative abundance of the golden sun moth, *Synemon plana* Walker, were carried out in remnant grasslands of Macgregor West in western Belconnen, ACT. These surveys revealed that *S. plana* is concentrated mainly along the Ginninderra Creek corridor and its drainage lines, with the highest density of sun moths occurring in an open-grassland flood plain comprising improved pasture where the putative larval food plant, *Nassella neesiana* (Trin. & Rupr.) Barkworth (Chilean needle grass) (Poaceae), grows as the dominant species. The flood plain habitat and the sun moth's association with this perennial exotic grass from South America are both unique in terms of current ecological knowledge of this threatened castniid. Supplementary observations made at Reid in central Canberra, ACT, strongly suggest that *Bothriochloa macra* (Steud.) S.T. Blake (redleg grass) is also utilised. Further studies are needed to determine larval diet breadth and food plant preferences of *S. plana*, and to clarify the extent to which the species utilises introduced perennial grasses, in order to provide an effective conservation management plan.

Introduction

The golden sun moth, *Synemon plana* Walker, is currently listed as 'Critically Endangered' nationally, and 'Endangered' in all States and Territories where it occurs. It is limited to native temperate perennial grasslands and grassy open woodlands in southeastern Australia, and has been a flagship species for the conservation of these habitats.

Prior to European settlement, *S. plana* was widespread within this broad geographic area; historical records show it has been recorded from many localities from near Bathurst, New South Wales (NSW), through the Australian Capital Territory (ACT) and Victoria, to Bordertown, South Australia (Edwards 1993, 1994). However, as a direct result of habitat loss and degradation, its area of distribution has contracted substantially, with only a limited number of relatively small, isolated populations surviving within the now very fragmented landscape (Douglas 1993, 2004, Clarke and O'Dwyer 1997, O'Dwyer and Attiwill 1999, ACT Government 2005). Possibly less than 1% of the original breeding habitat now remains and weeds heavily degrade much of this. Clearing and habitat modification, particularly the conversion of native perennial grasslands for agriculture, either by ploughing or with the introduction of pasture grasses, are the primary factors responsible for the widespread loss of native habitat, particularly in NSW and Victoria. Urban and industrial development has also contributed to habitat loss and fragmentation (ACT Government 2005).

Prior to 2000, *S. plana* was known only from 12 sites in the ACT (Clarke and O'Dwyer 1997, Clarke and Dunford 1999) but, between 2002 and 2004, one of us (MD) located a number of additional sites in the ACT (sites being defined on the extent of their discontinuity with other habitat patches, and/or according to land tenure).

Currently, *S. plana* is recorded from 31 sites within the ACT and from 42 sites in NSW, all within 85 km of the northern and northeastern borders of the ACT (ACT Government 2005, Department of Environment and Conservation NSW 2005, M. Dunford unpublished data). These sites vary in size and quality: of the ACT sites, 14 (45%) are relatively small (< 10 ha, with a combined total area of about 50 ha), and some are possibly no longer extant, while 17 (55%) sites are considerably larger (> 10 ha, with a combined total area of about 740 ha). However, ACT Government (2005) estimates that only about 20% of grassland patches where the species is known to occur in the ACT are protected in reserves, although this is likely to increase to around 25%. Eight of the ACT sites are significant in terms of the extent of the breeding area and/or relative abundance, and have high conservation value (ACT Government 2005). All sites in the ACT and nearby areas in NSW occur below 700 m.

The life history and larval food plants of *S. plana*, and indeed for the genus *Synemon* Doubleday, are poorly recorded in the literature, with only *S. magnifica* Strand described in detail (Common and Edwards 1981, Edwards *et al.* 1999). The food plants of *Synemon* comprise various monocotyledons, including Poaceae, Cyperaceae, Ecdeiocoleaceae and Lomandraceae (Edwards 1996, Edwards *et al.* 1999).

The putative larval food plants of *S. plana* include species of native perennial grasses in the genera *Austrodanthonia* H.P. Linder (wallaby grass) and *Austrostipa* S.W.L. Jacobs & J. Everett (speargrass) (both Poaceae). In the ACT, the preferred species is apparently *Austrodanthonia carphoides* (Benth.) H.P. Linder (Edwards 1990, 1993), although at some sites where this grass is absent or in very low abundance other species are almost certainly utilised (A. Rowell pers. comm.). In Victoria, *S. plana* is associated with several species of *Austrodanthonia* (Douglas 1993, O'Dwyer and Attiwill 1999), as well as *Austrostipa scabra* (Lindl.) S.W.L. Jacobs & J. Everett in the Wimmera (F. Douglas unpublished data). The larvae of *S. plana*, like many other Australian castniids, feed underground on the roots.

Here, we report on general observations made on the habitat preference and putative larval food plant of *S. plana* at a hitherto unknown site in Macgregor West, ACT, which one of us (MFB) first located in December 2002. The site occurs 3 km south-west of an extant colony in the Dunlop Grasslands Nature Reserve of western Belconnen. Additional observations made at a site in Reid in central Canberra, first recorded in November 2003 by MD, are also included.

Field observations

Macgregor West

Field surveys for the presence and relative abundance of *Synemon plana* were conducted in remnant grasslands of the Macgregor West district (35°12'S, 149°00'E; 560 m a.s.l.) in western Belconnen, ACT, during 7, 17 December 2003 and 5, 11-22 December 2004 (Braby 2005). These surveys revealed that *S. plana* was abundant and widespread in the area (total breeding area *ca* 70 ha) and more extensive than the colony nearby at Dunlop Grasslands Nature Reserve, the only other known extant site in western Belconnen. However, the population was found to be concentrated mainly along Ginninderra Creek and its drainage lines, with the core breeding area occurring in an open grassland flood plain comprising improved pasture (Fig. 1). This flood plain habitat stretched as a broad linear strip, approximately 700 m long by 100-200 m wide, along the Ginninderra Creek corridor north-west to the confluence of Gooromon Creek, and then continued more narrowly (*ca* 30-40 m wide) for about 1 km south-west along Ginninderra Creek towards the ACT/NSW border.

Within the flood plain habitat, patrolling males of *S. plana* were noted to be strongly associated with extensive patches of introduced Chilean needle grass, *Nassella neesiana* (Trin. & Rupr.) Barkworth (Poaceae), formerly known as *Stipa neesiana* Trinius & Ruprecht (Jacobs and Everett 1996). This grass species is the dominant plant in the flood plain habitat at Ginninderra Creek (Rowell 2005). Subsequently, 12 empty pupal shells (5 of which were collected, 1 lodged in ANIC) were discovered protruding out of the soil amongst tussocks of *N. neesiana* in various locations along the flood plain (Fig. 2). In each case, no other species of grass, native or introduced, was found near the pupal shells, indicating that *N. neesiana* is probably used as a larval food plant in the Ginninderra Creek flood plain.

A second, smaller, concentration of sun moths was found to occur in open grassland comprising degraded native pasture on higher sloping ground in Macgregor West, about 300 m west of Ginninderra Creek. The larval food plant was not determined in this habitat; however, the slopes are dominated by *Austrostipa bigeniculata* (Hughes) S.W.L. Jacobs & J. Everett, with *Austrodanthonia* comprising only a small component (Rowell 2005).

Reid

At St John's Anglican Church, Reid (35°17'S, 149°08'E; 570 m a.s.l.) in central Canberra, ACT, a female *S. plana* was observed emerging from its pupal shell at 1115 h (EDST) on 14 November 2003. The specimen was captured and held for about 25 minutes while it expanded and dried its wings, and then released. The pupal case was noted protruding from a plant of *Bothriochloa macra* (Steud.) S.T. Blake (redleg grass), a native species endemic to southeastern Australia. Nine empty pupal shells (1 lodged in ANIC) were subsequently discovered protruding from within, or directly

adjacent to, tussocks of *B. macra* on 22 November 2003. In each case, the nearest other grass species was 30 cm or more from the pupal shell. A further four pupal shells were found closely associated with *B. macra* on 8 December 2005, when several females were also observed ovipositing at the base of this species between 1300-1400 h (EDST). The St John's Anglican Church site comprised a small (*ca* 0.2 ha), fragmented and highly disturbed urban remnant patch of grassland dominated by *B. macra, Trifolium* spp. and *Paspalum dilatatum* Poir.

Figs 1-2. *Synemon plana* ecology at Ginninderra Creek, Macgregor West, ACT: (1) open grassland flood plain habitat, with patches of *Nassella neesiana* in foreground; note cattle grazing in background. (2) pupal exuvium protruding from tussock of *N. neesiana*. Photos: M.F. Braby.

Discussion

The presence of *Synemon plana* in an open grassland flood plain ecosystem and its association with *Nassella neesiana*, an exotic grass introduced from South America, closely related to *Stipa* L. and more distantly related to *Austrostipa* (Gardner *et al.* 1996, Jacobs and Everett 1996), represent a unique situation that contrasts markedly with all other known sites of *S. plana* throughout its range (Edwards 1994, Douglas 2004, ACT Government 2005). The density of sun moths in this flood plain habitat is also extremely large; for example, during the peak flight period in mid December 2004, close to 1200 individuals were counted along a 650 m x 50 m transect in the Ginninderra Creek flood plain (Braby 2005). Much of the habitat in the flood plain has been grazed by cattle (Fig. 1), which have significantly reduced both the plant biomass and competition from other weeds, creating conditions beneficial to *S. plana*, although in early 2005 cattle were excluded from the area (Rowell 2005).

Further long-term studies are needed to determine if the occurrence of *S. plana* in the flood plain represents the normal situation or is an unusual (short-term) response to extreme dry conditions that have occurred over the past three seasons (2002-2005). *S. plana* also occurs in significant numbers in the central drier slopes of Macgregor West, a short distance from Ginninderra Creek; it is possible that this secondary area serves as an important breeding habitat during wetter years when the flood plain may be potentially unsuitable for larval survival.

Although the presence of pupal shells provides only circumstantial evidence, it is highly likely that *S. plana* is utilising, as larval food plants, *N. neesiana* at the Ginninderra Creek flood plain in Macgregor West and *Bothriochloa macra* at the St John's Anglican Church site in Reid, particularly since the larvae are believed not to move underground between roots of adjacent grass tussocks (F. Douglas pers. comm., A. Rowell pers. comm.). Moreover, in the former habitat, *Austrodanthonia* comprises a relatively minor component (< 5% cover), whereas *N. neesiana* is the dominant species, growing in relatively large patches with up to 70% cover abundance in surveyed quadrats (Rowell 2005). Similarly, at the latter site, *Austrodanthonia* comprises less than 10% cover (M. Dunford unpublished data).

In the Ginninderra Creek flood plain, *N. neesiana* has possibly displaced much of the native grasses normally utilised by *S. plana*. Presumably, *S. plana* has been able to supplement or even switch its larval diet to a related but non-indigenous plant. Such a switch, however, does not necessarily imply that *S. plana* is dependant on *N. neesiana*; nor has it adapted to a range of other introduced grasses, many of which are weeds in the Australian landscape. On current knowledge, *S. plana* should be regarded as an ecological specialist dependent on a narrow range of native grasses (*Austrodanthonia, Austrostipa*, *Bothriochloa*) and, in some circumstances,

also utilises an introduced grass (*Nassella*) when the native grasses have been significantly depleted. Clearly, further studies are needed on the ecological requirements of *S. plana* and to clarify the extent to which the sun moth utilises *N. neesiana*.

The association of *S. plana* with *N. neesiana* is of biogeographical interest because the castniids have a Gondwanan distribution pattern, with disjunct occurrences in Australia, Central and South America, and Asia (Edwards *et al.* 1999). Members from Australia and Central and South America belong in the subfamily Castniinae, while those from Asia are currently placed in the subfamily Tascininae.

The Castniinae are composed of two tribes: the Synemonini, which are restricted to Australia, and the Castniini, which are endemic to Central and South America. [The Castniinae have recently become established in the Mediterranean through accidental introduction: Sarto I Monteys *et al.* 2005]. Both of these tribes are believed to be monophyletic and represent vicariant sister groups that differentiated after the break-up of southern Gondwana (Australia-Antarctica-South America) (Holloway and Hall 1998). It is therefore possible that the association of *Synemon* (endemic to the Australian Region) with *Nassella* (endemic to the Neotropical Region) may reflect an historical biogeographic relationship between the castniids of Australia and South America.

In South America, *N. neesiana* occurs widely in the cool montane areas of the Andes in Ecuador, Peru, Bolivia and Argentina, as well as in the temperate areas of southern Brazil, Paraguay and Uruguay (Missouri Botanic Garden 2005). In Chile, however, it is rare and restricted, currently protected and listed as a threatened species (A. Ugarte pers. comm.). *Nassella* is not known to serve as a larval food plant for the Neotropical castniids, but food plants (all monocots, including the families Arecaceae, Bromeliaceae, Marantaceae, Musaceae, Orchidaceae, Poaceae) have been recorded for only a few species of Castniini (Edwards *et al.* 1999, Sarto I Monteys *et al.* 2005), most of which occur in tropical forest. Only one species, *Castnia eudesmia* Gray, which feeds internally on the flower stems of *Puya chilensis* Molina (Bromeliaceae), is known to occur in the temperate areas of Chile (A. Ugarte pers. comm.).

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FIRST RECORD OF *EUCHRYSOPS CNEJUS* (FABRICIUS) (LEPIDOPTERA: LYCAENIDAE) ON CHRISTMAS ISLAND, INDIAN OCEAN

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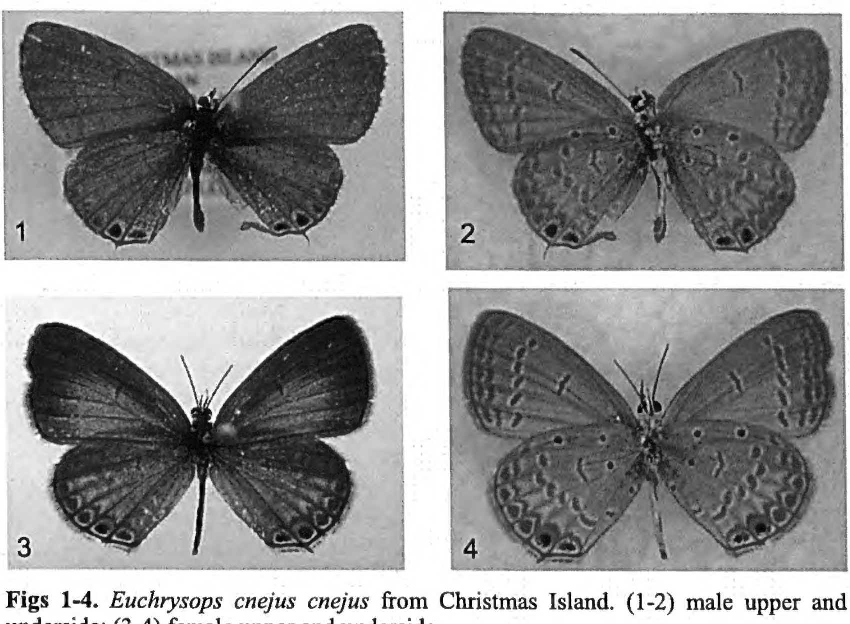
Abstract

The spotted pea-blue, *Euchrysops cnejus cnejus* (Fabricius), is recorded for the first time from Christmas Island in the Indian Ocean.

Introduction

Christmas Island (10°30'S, 105°35'E) is located in the Indian Ocean, about 360 km south of the Indonesian island of Java, and some 1400 km northwest of Western Australia. It covers an area of approximately 137 km^2 and much of the island supports tropical rainforest. Its butterfly fauna is incompletely known, the first specimens being collected there by officers of HMS *Flying Fish* (Butler 1887). Since then, a number of lepidopterists have visited the island, progressively adding to the list of known species. Moulds and Lachlan (1987) summarised the history of collections reported from Christmas Island up to that time and added seven more species to the list. The most recent additions are *Papilio memnon* L. (Braby 2000, Moulds and Humphrey 2000) and *Appias olferna* Swinhoe (Lambkin and Knight 2004).



Figs 1-4. *Euchrysops cnejus cnejus* from Christmas Island. (1-2) male upper and underside; (3-4) female upper and underside.

In October-November 2004, one of us (DA) visited the island and made opportunistic collections of butterflies. Among the specimens collected were a male and a female *Euchrysops cnejus* (Fabricius), a species not previously known from the island. These two specimens were flying with a number of *Zizina otis* (Fabricius) around small black-flowered peas growing at a disturbed roadside site. This brings the total number of butterfly species known from Christmas Island to 24.

Euchrysops cnejus cnejus (Fabricius)

Material examined. CHRISTMAS ISLAND: 1♂, 1♀, 4.xi.2004, D. Algar (in WA Dept. of Conservation and Land Management [CALM] Lepidoptera collection).

Comments. The above specimens (Figs 1-4) are relatively small (wingspan of male 25.5 mm, of female 26.0 mm) but the hindwing underside markings are unmistakable. Smaller and lighter in colour than *E. c. cnidus* Waterhouse & Lyell from the Kimberley region of northwestern Australia, they more closely resemble *E. c. cnejus*, a subspecies which occurs widely in Indonesia, and we tentatively include these specimens with the latter subspecies.

The status of *E. cnejus* on Christmas Island is uncertain. It might be a recent arrival but, given that the collecting effort in the past has not been great, and sporadic seasonally, it could well have been overlooked. The fact that the two collected specimens were active around a black-flowered pea strongly suggests that this is its larval food plant. In Australia, *E. c. cnidus* food plants are all members of the pea family Fabaceae (Braby 2000). Indeed, four of the lycaenid butterflies previously recorded from Christmas I., *Prosotas dubiosa* (Semper), *Catochrysops panormus* (C. Felder), *Lampides boeticus* (L.) and *Zizina otis*, also utilise food plants in this family (Braby 2000, 2004).

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